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| (54) Title: HUMAN CALCIUM-BINDING PROTEINS  |  |   |   |
| (57) Abstract   |  |   |   |
| <p>The invention provides human calcium-binding proteins (CaBPs) and polynucleotides which identify and encode CaBP. The invention also provides expression vectors, host cells, antibodies, agonists, and antagonists. The invention also provides methods for treating or preventing disorders associated with expression of CaBP.</p>  |  |   |   |

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## HUMAN CALCIUM-BINDING PROTEINS

### TECHNICAL FIELD

5 This invention relates to nucleic acid and amino acid sequences of human calcium-binding proteins and to the use of these sequences in the diagnosis, treatment, and prevention of nervous, vesicle trafficking, developmental, neoplastic, immunological, and reproductive disorders.

### 10 BACKGROUND OF THE INVENTION

Changes in cytosolic calcium ion concentrations ( $[Ca^{2+}]_i$ ) evoke a wide range of cellular responses. Intracellular  $Ca^{2+}$ -binding proteins are the key molecules in transducing  $Ca^{2+}$  signaling via enzymatic reactions or modulation of protein-protein interactions, some of which contribute to cell cycle events, and/or to cellular differentiation. Following stimulation of the cell by an external signal, second messenger molecules such as inositoltrisphosphate stimulate the brief release of  $[Ca^{2+}]_i$  from the endoplasmic reticulum into the surrounding cytoplasm. Similar second messenger signaling pathways also occur in the dividing cell nucleus during breakdown of the nuclear membrane and segregation of chromatids during anaphase.

20 The calcium-binding domain of many proteins contains the high affinity  $Ca^{2+}$ -binding motif often referred to as the EF-hand. The EF-hand is characterized by a twelve amino acid residue-containing loop, flanked by two  $\alpha$ -helices oriented approximately  $90^\circ$  with respect to one another. Aspartate (D), and glutamate (E) or aspartate residues are usually found at positions 10 and 21, respectively, bordering the twelve amino acid loop.

25 In addition, a conserved glycine residue in the central portion of the loop is found in most  $Ca^{2+}$ -binding EF-hand domains. Oxygen ligands within this domain coordinate the  $Ca^{2+}$  ion. Other non-EF-hand domain,  $Ca^{2+}$ -binding proteins (CBPs) bind  $Ca^{2+}$  using different protein conformations. (Kretsinger, R.H. and Nockolds, C.E. (1973) J. Biol. Chem. 248:3313-3326; and Celio, M.R. et al. (1996) Guidebook to Calcium-binding Proteins,  
30 Oxford University Press, Oxford, UK, pp. 15-20.)

Calmodulin (CaM) is the most widely distributed and the most common mediator

of calcium effects. (Celio et al., *supra* pp. 34-40.) CaM appears to be the primary sensor of  $[Ca^{2+}]_i$  changes in eukaryotic cells. The binding of  $Ca^{2+}$  to CaM induces marked conformational changes in the protein permitting interaction with, and regulation of over 100 different proteins. CaM interactions are involved in a multitude of cellular processes including, but not limited to, gene regulation, DNA synthesis, cell cycle progression, 5 mitosis, cytokinesis, cytoskeletal organization, muscle contraction, signal transduction, ion homeostasis, exocytosis, and metabolic regulation.

CaM contains two pairs of EF-hand domains which are located in the N and C-terminal halves of the molecule and connected by a flexible central helix. Binding of  $Ca^{2+}$  10 to the EF-hand domains of CaM induces a conformational change in the protein. In the presence of a target peptide, a further conformational change results in the flexible central helix being partially unwound and wrapped around the target peptide. In this manner, CaM interacts with a wide variety of target proteins. Several post-translational modifications of CaM including acylation of the amino terminus and phosphorylation of 15 various serine and threonine residues have been reported.

The regulation of CBPs has implications for the control of a variety of disorders. Calcineurin, a CaM-regulated protein phosphatase, is a target for inhibition by the immunosuppressive agents cyclosporin and FK506. This indicates the importance of calcineurin and CaM in the immune response and immune disorders. (Schwaninger M. et 20 al. (1993) J. Biol Chem. 268:23111-23115.) The level of CaM is increased several-fold in tumors and tumor-derived cell lines for various types of cancer. (Rasmussen, C.D. and Means, A.R. (1989) Trends in Neuroscience 12:433-438.)

The S100 proteins are a group of acidic  $Ca^{2+}$ -binding proteins with mass of approximately 10-12 kDa. These proteins are so named after the solubility of the first 25 isolated protein in 100% saturated ammonium sulfate. The S100 proteins have two  $Ca^{2+}$ -binding domains. One domain is a low affinity  $Ca^{2+}$ -binding, basic helix-loop-helix site, the other domain is a high affinity  $Ca^{2+}$ -binding EF-hand type, acidic helix-loop-helix site. (Kligman, D. and Hilt, D.C. (1988) Trends Biochem. Sci. 13:437-442.) The EF-hand domain also encompasses a part of a region that specifically identifies members of the 30 S100 family of proteins, but does not predict the  $Ca^{2+}$ -binding properties of the region. (See, e.g., SWISSPROT PROSITE pattern. accession number PS00303.) The distribution of particular S100 proteins is dependent on specific cell types, indicating that S100

proteins may be involved in transducing signals of increasing intracellular calcium in a cell type-specific fashion. For example, S100A13 protein is present in human and murine heart and skeletal muscle, and many other members of the S100 protein family, e.g., S100 $\beta$ , are abundant in brain. (Wu, T. et al. (1997) J. Biol. Chem. 272:17145-17153.)

- 5 Elevated serum levels of S100 $\beta$  are associated with disseminated malignant melanoma metastases, suggesting that serum S100 $\beta$  may be of value as a clinical marker for progression of metastatic melanoma. (Henze, G. et al. (1997) Dermatology 194:208-212.) Messenger RNA levels encoding both an S-100-like protein named calgizzarin and phospholipase A<sub>2</sub> are elevated in colorectal cancers compared with those of normal  
10 colorectal mucosa. (Tanaka, M. et al. (1995) Cancer Lett. 89:195-200.)

- The frequenin/neuronal calcium sensor protein from frog is a highly conserved protein that regulates rhodopsin phosphorylation and is found across a broad spectrum of phyla. It is present in the retina or other photosensitive organs of vertebrates, arthropods, molluscs, and nematodes; and in yeast. (De Castro, E. et al. (1995) Biochem. Biophys.  
15 Res. Comm. 216:133-140.)

- Calcineurin homologous protein (CHP) and p22 are homologous CBPs which contain EF-hand motifs and show extensive protein sequence similarity to the regulatory subunit of protein phosphatase 2B, calcineurin B. (Lin, X. and Barber, D. L. (1996) Proc. Natl. Acad. Sci. 93: 12631-12636; and Barroso, M. R. et al. (1996) J. Biol. Chem. 271:  
20 10183-10187.) CHP is widely expressed in human tissues. It specifically binds to and regulates the activity of NHE1, a ubiquitously expressed Na<sup>+</sup>/H<sup>+</sup> exchanger. Activation of NHE1 results in an increase in intracellular pH, which in turn activates cell proliferation, differentiation, and neoplastic transformation. The phosphorylation state of CHP is  
important for NHE1 regulation during cell division, and transient overexpression of CHP  
25 inhibits serum- and GTPase-stimulated NHE1 activities. (Lin and Barber, *supra*.) p22 is a cytosolic N-myristoylated phosphoprotein which undergoes conformational changes upon binding of calcium. p22 is ubiquitously expressed and may be required for regulating constitutive endocytic, membrane trafficking events. (Barroso et al., *supra*.)

- Two CBPs associated with metaplasia and neoplasia are osteonectin and recoverin.  
30 Osteonectin is an anti-adhesive secreted glycoprotein involved in tissue remodeling and has one EF-hand, and a protein-protein or protein-heparin interaction domain. Recoverin was identified as an antigen in cancer-associated retinopathy, and is implicated in the

pathway from retinal rod guanylate cyclase to rhodopsin. Recoverin is N-myristoylated at the N-terminus, and has three  $\text{Ca}^{2+}$ -binding sites including one low affinity  $\text{Ca}^{2+}$ -binding site and one high affinity  $\text{Ca}^{2+}$ -binding site. (Hohenester, E. et al. (1997) EMBO J. 16:3778-3786; and Murakami, A. et al. (1992) Biochem. Biophys. Res. Comm. 187:234-  
5 244.)

The discovery of new human calcium-binding proteins and the polynucleotides encoding them satisfies a need in the art by providing new compositions which are useful in the diagnosis, treatment, and prevention of nervous, vesicle trafficking, developmental, neoplastic, immunological, and reproductive disorders.

10

### SUMMARY OF THE INVENTION

The invention features a substantially purified polypeptide, human calcium-binding protein, having an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, and SEQ ID NO:3, or fragments thereof.

15 The invention further provides a substantially purified variant having at least 90% amino acid identity to the amino acid sequences of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or to a fragment of any of these sequences. The invention also provides an isolated and purified polynucleotide encoding the polypeptide comprising an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or  
20 fragments thereof. The invention also includes an isolated and purified polynucleotide variant having at least 90% polynucleotide sequence identity to the polynucleotide encoding the polypeptide comprising an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof.

Additionally, the invention provides an isolated and purified polynucleotide which  
25 hybridizes under stringent conditions to the polynucleotide encoding the polypeptide comprising an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof, as well as an isolated and purified polynucleotide having a sequence which is complementary to the polynucleotide encoding the polypeptide comprising the amino acid sequence selected from the group consisting of  
30 SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof.

The invention also provides an isolated and purified polynucleotide comprising a polynucleotide sequence selected from the group consisting of SEQ ID NO:4, SEQ ID

NO:5, SEQ ID NO:6, or fragments thereof. The invention further provides an isolated and purified polynucleotide variant having at least 90% polynucleotide sequence identity to the polynucleotide sequence comprising a polynucleotide sequence selected from the group consisting of SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, or fragment thereof, as well as  
5 an isolated and purified polynucleotide having a sequence which is complementary to the polynucleotide comprising a polynucleotide sequence selected from the group consisting of SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, or fragments thereof.

The invention further provides an expression vector containing at least a fragment of the polynucleotide encoding the polypeptide comprising an amino acid sequence  
10 selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof. In another aspect, the expression vector is contained within a host cell.

The invention also provides a method for producing a polypeptide comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof, the method comprising the steps of: (a) culturing the  
15 host cell containing an expression vector containing at least a fragment of a polynucleotide encoding the polypeptide under conditions suitable for the expression of the polypeptide; and (b) recovering the polypeptide from the host cell culture.

The invention also provides a pharmaceutical composition comprising a substantially purified polypeptide having the amino acid sequence selected from the group  
20 consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof in conjunction with a suitable pharmaceutical carrier.

The invention further includes a purified antibody which binds to a polypeptide comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof, as well as a purified agonist and a  
25 purified antagonist to the polypeptide.

The invention also provides a method for treating or preventing a nervous disorder, the method comprising administering to a subject in need of such treatment an effective amount of a pharmaceutical composition comprising a substantially purified polypeptide having an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ  
30 ID NO:2, SEQ ID NO:3, or fragments thereof.

The invention also provides a method for treating or preventing a vesicle trafficking disorder, the method comprising administering to a subject in need of such

treatment an effective amount of a pharmaceutical composition comprising a substantially purified polypeptide having an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof.

The invention also provides a method for treating or preventing a developmental  
5 disorder, the method comprising administering to a subject in need of such treatment an effective amount of a pharmaceutical composition comprising a substantially purified polypeptide having an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof.

The invention also provides a method for treating or preventing a neoplastic  
10 disorder, the method comprising administering to a subject in need of such treatment an effective amount of an antagonist of the polypeptide having an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof.

The invention also provides a method for treating or preventing an immunological  
15 disorder, the method comprising administering to a subject in need of such treatment an effective amount of an antagonist of the polypeptide having an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof.

The invention also provides a method for treating or preventing a reproductive  
20 disorder, the method comprising administering to a subject in need of such treatment an effective amount of an antagonist of the polypeptide having an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof.

The invention also provides a method for detecting a polynucleotide encoding the  
25 polypeptide comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof, in a biological sample containing nucleic acids, the method comprising the steps of: (a) hybridizing the complement of the polynucleotide sequence encoding the polypeptide comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2,  
30 SEQ ID NO:3, or fragments thereof, to at least one of the nucleic acids of the biological sample, thereby forming a hybridization complex; and (b) detecting the hybridization complex, wherein the presence of the hybridization complex correlates with the presence



of a polynucleotide encoding the polypeptide in the biological sample. In one aspect, the nucleic acids of the biological sample are amplified by the polymerase chain reaction prior to the hybridizing step.

5

## BRIEF DESCRIPTION OF THE FIGURES

Figures 1A, 1B, and 1C show the amino acid sequence alignments among CaBP-1 (2061917; SEQ ID NO:1), CaBP-2 (2287407; SEQ ID NO:2), CaBP-3 (2379155; SEQ ID NO:3), and the EF-hand motif, produced using the multisequence alignment program of LASERGENE™ software (DNASTAR Inc, Madison, WI).

10

## DESCRIPTION OF THE INVENTION

Before the present proteins, nucleotide sequences, and methods are described, it is understood that this invention is not limited to the particular methodology, protocols, cell lines, vectors, and reagents described, as these may vary. It is also to be understood that  
15 the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of the present invention which will be limited only by the appended claims.

It must be noted that as used herein and in the appended claims, the singular forms “a,” “an,” and “the” include plural reference unless the context clearly dictates otherwise.  
20 Thus, for example, a reference to “a host cell” includes a plurality of such host cells, and a reference to “an antibody” is a reference to one or more antibodies and equivalents thereof known to those skilled in the art, and so forth.

Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art to which this  
25 invention belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, the preferred methods, devices, and materials are now described. All publications mentioned herein are cited for the purpose of describing and disclosing the cell lines, vectors, and methodologies which are reported in the publications and which might be used in  
30 connection with the invention. Nothing herein is to be construed as an admission that the invention is not entitled to antedate such disclosure by virtue of prior invention.

**DEFINITIONS**

"CaBP," as used herein, refers to the amino acid sequences of substantially purified CaBP obtained from any species, particularly a mammalian species, including bovine, ovine, porcine, murine, equine, and preferably the human species, from any source, whether natural, synthetic, semi-synthetic, or recombinant.

The term "agonist," as used herein, refers to a molecule which, when bound to CaBP, increases or prolongs the duration of the effect of CaBP. Agonists may include proteins, nucleic acids, carbohydrates, or any other molecules which bind to and modulate the effect of CaBP.

An "allele" or an "allelic sequence," as these terms are used herein, is an alternative form of the gene encoding CaBP. Alleles may result from at least one mutation in the nucleic acid sequence and may result in altered mRNAs or in polypeptides whose structure or function may or may not be altered. Any given natural or recombinant gene may have none, one, or many allelic forms. Common mutational changes which give rise to alleles are generally ascribed to natural deletions, additions, or substitutions of nucleotides. Each of these types of changes may occur alone, or in combination with the others, one or more times in a given sequence.

"Altered" nucleic acid sequences encoding CaBP, as described herein, include those sequences with deletions, insertions, or substitutions of different nucleotides, resulting in a polynucleotide the same CaBP or a polypeptide with at least one functional characteristic of CaBP. Included within this definition are polymorphisms which may or may not be readily detectable using a particular oligonucleotide probe of the polynucleotide encoding CaBP, and improper or unexpected hybridization to alleles, with a locus other than the normal chromosomal locus for the polynucleotide sequence encoding CaBP. The encoded protein may also be "altered," and may contain deletions, insertions, or substitutions of amino acid residues which produce a silent change and result in a functionally equivalent CaBP. Deliberate amino acid substitutions may be made on the basis of similarity in polarity, charge, solubility, hydrophobicity, hydrophilicity, and/or the amphipathic nature of the residues, as long as the biological or immunological activity of CaBP is retained. For example, negatively charged amino acids may include aspartic acid and glutamic acid, positively charged amino acids may include lysine and arginine, and amino acids with uncharged polar head groups having similar hydrophilicity values

may include leucine, isoleucine, and valine; glycine and alanine; asparagine and glutamine; serine and threonine; and phenylalanine and tyrosine.

The terms "amino acid" or "amino acid sequence," as used herein, refer to an oligopeptide, peptide, polypeptide, or protein sequence, or a fragment of any of these, and  
5 to naturally occurring or synthetic molecules. In this context, "fragments", "immunogenic fragments", or "antigenic fragments" refer to fragments of CaBP which are preferably about 5 to about 15 amino acids in length and which retain some biological activity or immunological activity of CaBP. Where "amino acid sequence" is recited herein to refer to an amino acid sequence of a naturally occurring protein molecule, "amino acid  
10 sequence" and like terms are not meant to limit the amino acid sequence to the complete native amino acid sequence associated with the recited protein molecule.

"Amplification," as used herein, relates to the production of additional copies of a nucleic acid sequence. Amplification is generally carried out using polymerase chain reaction (PCR) technologies well known in the art. (See, e.g., Dieffenbach, C.W. and G.S.  
15 Dveksler (1995) PCR Primer, a Laboratory Manual, Cold Spring Harbor Press, Plainview, NY, pp.1-5.)

The term "antagonist," as it is used herein, refers to a molecule which, when bound to CaBP, decreases the amount or the duration of the effect of the biological or immunological activity of CaBP. Antagonists may include proteins, nucleic acids,  
20 carbohydrates, antibodies, or any other molecules which decrease the effect of CaBP.

As used herein, the term "antibody" refers to intact molecules as well as to fragments thereof, such as Fa, F(ab')<sub>2</sub>, and Fv fragments, which are capable of binding the epitopic determinant. Antibodies that bind CaBP polypeptides can be prepared using intact polypeptides or using fragments containing small peptides of interest as the  
25 immunizing antigen. The polypeptide or oligopeptide used to immunize an animal (e.g., a mouse, a rat, or a rabbit) can be derived from the translation of RNA, or synthesized chemically, and can be conjugated to a carrier protein if desired. Commonly used carriers that are chemically coupled to peptides include bovine serum albumin, thyroglobulin, and keyhole limpet hemocyanin (KLH). The coupled peptide is then used to immunize the  
30 animal.

The term "antigenic determinant," as used herein, refers to that fragment of a molecule (i.e., an epitope) that makes contact with a particular antibody. When a protein

or a fragment of a protein is used to immunize a host animal, numerous regions of the protein may induce the production of antibodies which bind specifically to antigenic determinants (given regions or three-dimensional structures on the protein). An antigenic determinant may compete with the intact antigen (i.e., the immunogen used to elicit the  
5 immune response) for binding to an antibody.

The term "antisense," as used herein, refers to any composition containing a nucleic acid sequence which is complementary to a specific nucleic acid sequence. The term "antisense strand" is used in reference to a nucleic acid strand that is complementary to the "sense" strand. Antisense molecules may be produced by any method including  
10 synthesis or transcription. Once introduced into a cell, the complementary nucleotides combine with natural sequences produced by the cell to form duplexes and to block either transcription or translation. The designation "negative" can refer to the antisense strand, and the designation "positive" can refer to the sense strand.

As used herein, the term "biologically active," refers to a protein having structural,  
15 regulatory, or biochemical functions of a naturally occurring molecule. Likewise, "immunologically active" refers to the capability of the natural, recombinant, or synthetic CaBP, or of any oligopeptide thereof, to induce a specific immune response in appropriate animals or cells and to bind with specific antibodies.

The terms "complementary" or "complementarity," as used herein, refer to the  
20 natural binding of polynucleotides under permissive salt and temperature conditions by base pairing. For example, the sequence "A-G-T" binds to the complementary sequence "T-C-A." Complementarity between two single-stranded molecules may be "partial," such that only some of the nucleic acids bind, or it may be "complete," such that total complementarity exists between the single stranded molecules. The degree of  
25 complementarity between nucleic acid strands has significant effects on the efficiency and strength of the hybridization between the nucleic acid strands. This is of particular importance in amplification reactions, which depend upon binding between nucleic acids strands, and in the design and use of peptide nucleic acid (PNA) molecules.

A "composition comprising a given polynucleotide sequence" or a "composition  
30 comprising a given amino acid sequence," as these terms are used herein, refer broadly to any composition containing the given polynucleotide or amino acid sequence. The composition may comprise a dry formulation, an aqueous solution, or a sterile

composition. Compositions comprising polynucleotide sequences encoding CaBP or fragments of CaBP may be employed as hybridization probes. The probes may be stored in freeze-dried form and may be associated with a stabilizing agent such as a carbohydrate. In hybridizations, the probe may be deployed in an aqueous solution containing salts (e.g.,  
5 NaCl), detergents (e.g., SDS), and other components (e.g., Denhardt's solution, dry milk, salmon sperm DNA, etc.).

"Consensus sequence," as used herein, refers to a nucleic acid sequence which has been resequenced to resolve uncalled bases, extended using XL-PCR™ (Perkin Elmer, Norwalk, CT) in the 5' and/or the 3' direction, and resequenced, or which has been  
10 assembled from the overlapping sequences of more than one Incyte Clone using a computer program for fragment assembly, such as the GELVIEW™ Fragment Assembly system (GCG, Madison, WI). Some sequences have been both extended and assembled to produce the consensus sequence.

As used herein, the term "correlates with expression of a polynucleotide" indicates  
15 that the detection of the presence of nucleic acids, the same or related to a nucleic acid sequence encoding CaBP, by northern analysis is indicative of the presence of nucleic acids encoding CaBP in a sample, and thereby correlates with expression of the transcript from the polynucleotide encoding CaBP.

A "deletion," as the term is used herein, refers to a change in the amino acid or  
20 nucleotide sequence that results in the absence of one or more amino acid residues or nucleotides.

The term "derivative," as used herein, refers to the chemical modification of CaBP, of a polynucleotide sequence encoding CaBP, or of a polynucleotide sequence complementary to a polynucleotide sequence encoding CaBP. Chemical modifications of  
25 a polynucleotide sequence can include, for example, replacement of hydrogen by an alkyl, acyl, or amino group. A derivative polynucleotide encodes a polypeptide which retains at least one biological or immunological function of the natural molecule. A derivative polypeptide is one modified by glycosylation, pegylation, or any similar process that retains at least one biological or immunological function of the polypeptide from which it  
30 was derived.

The term "homology," as used herein, refers to a degree of complementarity. There may be partial homology or complete homology. The word "identity" may

substitute for the word "homology." A partially complementary sequence that at least partially inhibits an identical sequence from hybridizing to a target nucleic acid is referred to as "substantially homologous." The inhibition of hybridization of the completely complementary sequence to the target sequence may be examined using a hybridization  
5 assay (Southern or northern blot, solution hybridization, and the like) under conditions of reduced stringency. A substantially homologous sequence or hybridization probe will compete for and inhibit the binding of a completely homologous sequence to the target sequence under conditions of reduced stringency. This is not to say that conditions of reduced stringency are such that non-specific binding is permitted, as reduced stringency  
10 conditions require that the binding of two sequences to one another be a specific (i.e., a selective) interaction. The absence of non-specific binding may be tested by the use of a second target sequence which lacks even a partial degree of complementarity (e.g., less than about 30% homology or identity). In the absence of non-specific binding, the substantially homologous sequence or probe will not hybridize to the second non-  
15 complementary target sequence.

The phrases "percent identity" or "% identity" refer to the percentage of sequence similarity found in a comparison of two or more amino acid or nucleic acid sequences. Percent identity can be determined electronically, e.g., by using the MegAlign™ program (DNASTAR, Inc., Madison WI). The MegAlign™ program can create alignments  
20 between two or more sequences according to different methods, e.g., the clustal method. (See, e.g., Higgins, D.G. and P.M. Sharp (1988) Gene 73:237-244.) The clustal algorithm groups sequences into clusters by examining the distances between all pairs. The clusters are aligned pairwise and then in groups. The percentage similarity between two amino acid sequences, e.g., sequence A and sequence B, is calculated by dividing the length of  
25 sequence A, minus the number of gap residues in sequence A, minus the number of gap residues in sequence B, into the sum of the residue matches between sequence A and sequence B, times one hundred. Gaps of low or of no homology between the two amino acid sequences are not included in determining percentage similarity. Percent identity between nucleic acid sequences can also be counted or calculated by other methods known  
30 in the art, e.g., the Jotun Hein method. (See, e.g., Hein, J. (1990) Methods Enzymol. 183:626-645.) Identity between sequences can also be determined by other methods known in the art, e.g., by varying hybridization conditions.

"Human artificial chromosomes" (HACs), as described herein, are linear microchromosomes which may contain DNA sequences of about 6 kb to 10 Mb in size, and which contain all of the elements required for stable mitotic chromosome segregation and maintenance. (See, e.g., Harrington, J.J. et al. (1997) Nat Genet. 15:345-355.)

5       The term "humanized antibody," as used herein, refers to antibody molecules in which the amino acid sequence in the non-antigen binding regions has been altered so that the antibody more closely resembles a human antibody, and still retains its original binding ability.

      "Hybridization," as the term is used herein, refers to any process by which a strand  
10 of nucleic acid binds with a complementary strand through base pairing.

      As used herein, the term "hybridization complex" as used herein, refers to a complex formed between two nucleic acid sequences by virtue of the formation of hydrogen bonds between complementary bases. A hybridization complex may be formed in solution (e.g., C<sub>0</sub>t or R<sub>0</sub>t analysis) or formed between one nucleic acid sequence present  
15 in solution and another nucleic acid sequence immobilized on a solid support (e.g., paper, membranes, filters, chips, pins or glass slides, or any other appropriate substrate to which cells or their nucleic acids have been fixed).

      The words "insertion" or "addition," as used herein, refer to changes in an amino acid or nucleotide sequence resulting in the addition of one or more amino acid residues or  
20 nucleotides, respectively, to the sequence found in the naturally occurring molecule.

      "Immune response" can refer to conditions associated with inflammation, trauma, immune disorders, or infectious or genetic disease, etc. These conditions can be characterized by expression of various factors, e.g., cytokines, chemokines, and other signaling molecules, which may affect cellular and systemic defense systems.

25       The term "microarray," as used herein, refers to an arrangement of distinct polynucleotides arrayed on a substrate, e.g., paper, nylon or any other type of membrane, filter, chip, glass slide, or any other suitable solid support.

      The terms "element" or "array element" as used herein in a microarray context, refer to hybridizable polynucleotides arranged on the surface of a substrate.

30       The term "modulate," as it appears herein, refers to a change in the activity of CaBP. For example, modulation may cause an increase or a decrease in protein activity, binding characteristics, or any other biological, functional, or immunological properties of

CaBP.

The phrases "nucleic acid" or "nucleic acid sequence," as used herein, refer to an oligonucleotide, nucleotide, polynucleotide, or any fragment thereof, to DNA or RNA of genomic or synthetic origin which may be single-stranded or double-stranded and may  
5 represent the sense or the antisense strand, to peptide nucleic acid (PNA), or to any DNA-like or RNA-like material. In this context, "fragments" refers to those nucleic acid sequences which are greater than about 60 nucleotides in length, and most preferably are at least about 100 nucleotides, at least about 1000 nucleotides, or at least about 10,000 nucleotides in length.

10 The terms "operably associated" or "operably linked," as used herein, refer to functionally related nucleic acid sequences. A promoter is operably associated or operably linked with a coding sequence if the promoter controls the transcription of the encoded polypeptide. While operably associated or operably linked nucleic acid sequences can be contiguous and in the same reading frame, certain genetic elements, e.g., repressor genes,  
15 are not contiguously linked to the sequence encoding the polypeptide but still bind to operator sequences that control expression of the polypeptide.

The term "oligonucleotide," as used herein, refers to a nucleic acid sequence of at least about 6 nucleotides to 60 nucleotides, preferably about 15 to 30 nucleotides, and most preferably about 20 to 25 nucleotides, which can be used in PCR amplification or in  
20 a hybridization assay or microarray. As used herein, the term "oligonucleotide" is substantially equivalent to the terms "amplimer," "primer," "oligomer," and "probe," as these terms are commonly defined in the art.

"Peptide nucleic acid" (PNA), as used herein, refers to an antisense molecule or anti-gene agent which comprises an oligonucleotide of at least about 5 nucleotides in  
25 length linked to a peptide backbone of amino acid residues ending in lysine. The terminal lysine confers solubility to the composition. PNAs preferentially bind complementary single stranded DNA and RNA and stop transcript elongation, and may be pegylated to extend their lifespan in the cell. (See, e.g., Nielsen, P.E. et al. (1993) Anticancer Drug Des. 8:53-63.)

30 The term "sample," as used herein, is used in its broadest sense. A biological sample suspected of containing nucleic acids encoding CaBP, or fragments thereof, or CaBP itself, may comprise a bodily fluid; an extract from a cell, chromosome, organelle,



or membrane isolated from a cell; a cell; genomic DNA, RNA, or cDNA, in solution or bound to a solid support; a tissue; a tissue print; etc.

As used herein, the terms "specific binding" or "specifically binding" refer to that interaction between a protein or peptide and an agonist, an antibody, or an antagonist. The interaction is dependent upon the presence of a particular structure of the protein, e.g., the antigenic determinant or epitope, recognized by the binding molecule. For example, if an antibody is specific for epitope "A," the presence of a polypeptide containing the epitope A, or the presence of free unlabeled A, in a reaction containing free labeled A and the antibody will reduce the amount of labeled A that binds to the antibody.

As used herein, the term "stringent conditions" refers to conditions which permit hybridization between polynucleotide sequences and the claimed polynucleotide sequences. Suitably stringent conditions can be defined by, for example, the concentrations of salt or formamide in the prehybridization and hybridization solutions, or by the hybridization temperature, and are well known in the art. In particular, stringency can be increased by reducing the concentration of salt, increasing the concentration of formamide, or raising the hybridization temperature.

For example, hybridization under high stringency conditions could occur in about 50% formamide at about 37°C to 42°C. Hybridization could occur under reduced stringency conditions in about 35% to 25% formamide at about 30°C to 35°C. In particular, hybridization could occur under high stringency conditions at 42°C in 50% formamide, 5X SSPE, 0.3% SDS, and 200 µg/ml sheared and denatured salmon sperm DNA. Hybridization could occur under reduced stringency conditions as described above, but in 35% formamide at a reduced temperature of 35°C. The temperature range corresponding to a particular level of stringency can be further narrowed by calculating the purine to pyrimidine ratio of the nucleic acid of interest and adjusting the temperature accordingly. Variations on the above ranges and conditions are well known in the art.

The term "substantially purified," as used herein, refers to nucleic acid or amino acid sequences that are removed from their natural environment and are isolated or separated, and are at least about 60% free, preferably about 75% free, and most preferably about 90% free from other components with which they are naturally associated.

A "substitution," as used herein, refers to the replacement of one or more amino acids or nucleotides by different amino acids or nucleotides, respectively.

"Transformation," as defined herein, describes a process by which exogenous DNA enters and changes a recipient cell. Transformation may occur under natural or artificial conditions according to various methods well known in the art. and may rely on any known method for the insertion of foreign nucleic acid sequences into a prokaryotic or eukaryotic host cell. The method for transformation is selected based on the type of host cell being transformed and may include, but is not limited to, viral infection, electroporation, heat shock, lipofection, and particle bombardment. The term "transformed" cells includes stably transformed cells in which the inserted DNA is capable of replication either as an autonomously replicating plasmid or as part of the host chromosome, as well as transiently transformed cells which express the inserted DNA or RNA for limited periods of time.

A "variant" of CaBP, as used herein, refers to an amino acid sequence that is altered by one or more amino acids. The variant may have "conservative" changes, wherein a substituted amino acid has similar structural or chemical properties (e.g., replacement of leucine with isoleucine). More rarely, a variant may have "nonconservative" changes (e.g., replacement of glycine with tryptophan). Analogous minor variations may also include amino acid deletions or insertions, or both. Guidance in determining which amino acid residues may be substituted, inserted, or deleted without abolishing biological or immunological activity may be found using computer programs well known in the art, for example, LASERGENE™ software.

#### THE INVENTION

The invention is based on the discovery of new human calcium-binding proteins (CaBP), the polynucleotides encoding CaBP, and the use of these compositions for the diagnosis, treatment, or prevention of nervous, vesicle trafficking, developmental neoplastic, immunological, and reproductive disorders.

Nucleic acids encoding the CaBP-1 of the present invention were first identified in Incyte Clone 2061917 from the ovary cDNA library (OVARNOT03) using a computer search, e.g., BLAST, for amino acid sequence alignments. A consensus sequence, SEQ ID NO:4, was derived from the following overlapping and/or extended nucleic acid sequences: shotgun sequences SAEB01937 and SEAB000018, which have identity to Incyte Clone 2061917.

Nucleic acids encoding the CaBP-2 of the present invention were first identified in Incyte Clone 2287407 from the brain cDNA library (BRAINON01) using a computer search, e.g., BLAST, for amino acid sequence alignments. A consensus sequence, SEQ ID NO:5, was derived from extension of this clone.

5 Nucleic acids encoding the CaBP-3 of the present invention were first identified in Incyte Clone 2379155 from the pancreatic islet cDNA library (ISLTNOT01) using a computer search, e.g., BLAST, for amino acid sequence alignments. A consensus sequence, SEQ ID NO:6, was derived from the following overlapping and/or extended nucleic acid sequences: Incyte Clones 2379155 and 2377128 (ISLTNOT01), 1308358 and  
10 1311254 (COLNFET02), and 2773372 (PANCNOT15).

In one embodiment, the invention encompasses a polypeptide comprising the amino acid sequence of SEQ ID NO:1. As shown in Figures 1A, 1B, and 1C CaBP-1 is 153 amino acids in length and has four potential casein kinase II phosphorylation sites at residues S18, T45, S112, and T118; one potential protein kinase C phosphorylation site at  
15 residue T118; three EF-hand calcium-binding motifs from residues D21 through D32, D94 through D105, and D130 through E141; and a recoverin family signature from residues L125 through I146. A fragment of SEQ ID NO:4 from about nucleotide 365 to about nucleotide 394 is useful for designing oligonucleotides or to be used directly as a hybridization probe. Northern analysis shows the expression of this sequence in various  
20 libraries, at least 69% of which are immortalized or cancerous and at least 31% of which involve immune response. Of particular note is the expression of CaBP-1 in tumor-associated reproductive and nervous tissues, and in tumor-associated or inflammatory gastrointestinal tissues.

In one embodiment, the invention encompasses a polypeptide comprising the amino acid sequence of SEQ ID NO:2. As shown in Figures 1A, 1B, and 1C CaBP-2 is  
25 188 amino acids in length and has seven potential casein kinase II phosphorylation sites at residues T21, T45, S79, T94, T115, T163, and S170; three potential protein kinase C phosphorylation sites at residues T3, T21, and T45; three EF-hand calcium-binding motifs from residues D71 through D82, D107 through E118, and D155 through E166; and a  
30 recoverin family signature from residues G112 through F151. A fragment of SEQ ID NO:5 from about nucleotide 450 to about nucleotide 484 is useful for designing oligonucleotides or to be used directly as a hybridization probe. Northern analysis shows

the expression of this sequence in various libraries, at least 50% of which are immortalized or cancerous. Of particular note is the expression of CaBP-2 in oligoastrocytoma-associated cerebral cortex and Alzheimer's disease cerebellar tissue.

In one embodiment, the invention encompasses a polypeptide comprising the amino acid sequence of SEQ ID NO:3. As shown in Figures 1A, 1B, and 1C CaBP-3 is 276 amino acids in length and has seven potential casein kinase II phosphorylation sites at residues S3, T68, S89, S106, S126, S194, and S238; one potential protein kinase C phosphorylation site at residue S3; one potential tyrosine kinase phosphorylation site at residue Y31; five EF-hand calcium-binding motifs from residues D25 through E36, D71 through E82, D118 through E129, D162 through D173, D210 through E221, and D254 through E265; an osteonectin-like domain from residues L250 to K273; and a recoverin family signature from residues M157 to L178. A fragment of SEQ ID NO:6 from about nucleotide 662 to about nucleotide 688 is useful for designing oligonucleotides or to be used directly as a hybridization probe. Northern analysis shows the expression of this sequence in various libraries, at least 50% of which are immortalized or cancerous and at least 20% of which are in proliferating fetal tissue. Of particular note is the expression of CaBP-3 in fetal- or tumor-associated gastrointestinal tissues and in tumor-associated secretory tissues.

The invention also encompasses CaBP variants. A preferred CaBP variant is one which has at least about 80%, more preferably at least about 90%, and most preferably at least about 95% amino acid sequence identity to the CaBP amino acid sequence, and which contains at least one functional or structural characteristic of CaBP.

The invention also encompasses polynucleotides which encode CaBP. In a particular embodiment, the invention encompasses a polynucleotide sequence comprising the sequence of SEQ ID NO:4, which encodes a CaBP as shown in Figures 1A, 1B, and 1C. In a further embodiment, the invention encompasses the polynucleotide sequence comprising the sequence of SEQ ID NO:5, as shown in Figures 1A, 1B, and 1C. In a further embodiment, the invention encompasses the polynucleotide sequence comprising the sequence of SEQ ID NO:6, as shown in Figures 1A, 1B, and 1C.

The invention also encompasses a variant of a polynucleotide sequence encoding CaBP. In particular, such a variant polynucleotide sequence will have at least about 80%, more preferably at least about 90%, and most preferably at least about 95% polynucleotide

sequence identity to the polynucleotide sequence encoding CaBP. A particular aspect of the invention encompasses a variant of SEQ ID NO:4 which has at least about 80%, more preferably at least about 90%, and most preferably at least about 95% polynucleotide sequence identity to SEQ ID NO:4. The invention further encompasses a polynucleotide  
5 variant of SEQ ID NO:5 having at least about 80%, more preferably at least about 90%, and most preferably at least about 95% polynucleotide sequence identity to SEQ ID NO:5. The invention further encompasses a polynucleotide variant of SEQ ID NO:6 having at least about 80%, more preferably at least about 90%, and most preferably at least about 95% polynucleotide sequence identity to SEQ ID NO:6. Any one of the polynucleotide  
10 variants described above can encode an amino acid sequence which contains at least one functional or structural characteristic of CaBP.

It will be appreciated by those skilled in the art that as a result of the degeneracy of the genetic code, a multitude of polynucleotide sequences encoding CaBP, some bearing minimal homology to the polynucleotide sequences of any known and naturally occurring  
15 gene, may be produced. Thus, the invention contemplates each and every possible variation of polynucleotide sequence that could be made by selecting combinations based on possible codon choices. These combinations are made in accordance with the standard triplet genetic code as applied to the polynucleotide sequence of naturally occurring CaBP, and all such variations are to be considered as being specifically disclosed.

20 Although nucleotide sequences which encode CaBP and its variants are preferably capable of hybridizing to the nucleotide sequence of the naturally occurring CaBP under appropriately selected conditions of stringency, it may be advantageous to produce nucleotide sequences encoding CaBP or its derivatives possessing a substantially different codon usage. Codons may be selected to increase the rate at which expression of the  
25 peptide occurs in a particular prokaryotic or eukaryotic host in accordance with the frequency with which particular codons are utilized by the host. Other reasons for substantially altering the nucleotide sequence encoding CaBP and its derivatives without altering the encoded amino acid sequences include the production of RNA transcripts having more desirable properties, such as a greater half-life, than transcripts produced  
30 from the naturally occurring sequence.

The invention also encompasses production of DNA sequences which encode CaBP and CaBP derivatives, or fragments thereof, entirely by synthetic chemistry. After

production. the synthetic sequence may be inserted into any of the many available expression vectors and cell systems using reagents that are well known in the art. Moreover, synthetic chemistry may be used to introduce mutations into a sequence encoding CaBP or any fragment thereof.

5 Also encompassed by the invention are polynucleotide sequences that are capable of hybridizing to the claimed polynucleotide sequences, and, in particular, to those shown in SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, or fragments thereof under various conditions of stringency. (See, e.g., Wahl, G.M. and S.L. Berger (1987) *Methods Enzymol.* 152:399-407; Kimmel, A.R. (1987) *Methods Enzymol.* 152:507-511.)

10 Methods for DNA sequencing are well known and generally available in the art and may be used to practice any of the embodiments of the invention. The methods may employ such enzymes as the Klenow fragment of DNA polymerase I, Sequenase® (US Biochemical Corp., Cleveland, OH), Taq polymerase (Perkin Elmer), thermostable T7 polymerase (Amersham, Chicago, IL), or combinations of polymerases and proofreading  
15 exonucleases such as those found in the ELONGASE Amplification System (GIBCO/BRL, Gaithersburg, MD). Preferably, the process is automated with machines such as the Hamilton Micro Lab 2200 (Hamilton, Reno, NV), Peltier Thermal Cycler (PTC200; MJ Research, Watertown, MA) and the ABI Catalyst and 373 and 377 DNA Sequencers (Perkin Elmer).

20 The nucleic acid sequences encoding CaBP may be extended utilizing a partial nucleotide sequence and employing various methods known in the art to detect upstream sequences, such as promoters and regulatory elements. For example, one method which may be employed, restriction-site PCR, uses universal primers to retrieve unknown sequence adjacent to a known locus. (See, e.g., Sarkar, G. (1993) *PCR Methods Applic.*  
25 2:318-322.) In particular, genomic DNA is first amplified in the presence of a primer which is complementary to a linker sequence within the vector and a primer specific to a region of the nucleotide sequence. The amplified sequences are then subjected to a second round of PCR with the same linker primer and another specific primer internal to the first one. Products of each round of PCR are transcribed with an appropriate RNA polymerase  
30 and sequenced using reverse transcriptase.

Inverse PCR may also be used to amplify or extend sequences using divergent primers based on a known region. (See, e.g., Triglia, T. et al. (1988) *Nucleic Acids Res.*

16:8186.) The primers may be designed using commercially available software such as OLIGO 4.06 Primer Analysis software (National Biosciences Inc., Plymouth, MN) or another appropriate program to be about 22 to 30 nucleotides in length, to have a GC content of about 50% or more, and to anneal to the target sequence at temperatures of  
5 about 68°C to 72°C. The method uses several restriction enzymes to generate a suitable fragment in the known region of a gene. The fragment is then circularized by intramolecular ligation and used as a PCR template.

Another method which may be used is capture PCR, which involves PCR amplification of DNA fragments adjacent to a known sequence in human and yeast  
10 artificial chromosome DNA. (See, e.g., Lagerstrom, M. et al. (1991) PCR Methods Applic. 1:111-119.) In this method, multiple restriction enzyme digestions and ligations may be used to place an engineered double-stranded sequence into an unknown fragment of the DNA molecule before performing PCR. Other methods which may be used to retrieve unknown sequences are known in the art. (See, e.g., Parker, J.D. et al. (1991)  
15 Nucleic Acids Res. 19:3055-3060.) Additionally, one may use PCR, nested primers, and PromoterFinder™ libraries to walk genomic DNA (Clontech, Palo Alto, CA). This process avoids the need to screen libraries and is useful in finding intron/exon junctions.

When screening for full-length cDNAs, it is preferable to use libraries that have been size-selected to include larger cDNAs. Also, random-primed libraries are preferable  
20 in that they will include more sequences which contain the 5' regions of genes. Use of a randomly primed library may be especially preferable for situations in which an oligo d(T) library does not yield a full-length cDNA. Genomic libraries may be useful for extension of sequence into 5' non-transcribed regulatory regions.

Capillary electrophoresis systems which are commercially available may be used  
25 to analyze the size or confirm the nucleotide sequence of sequencing or PCR products. In particular, capillary sequencing may employ flowable polymers for electrophoretic separation, four different fluorescent dyes (one for each nucleotide) which are laser activated, and a charge coupled device camera for detection of the emitted wavelengths. Output/light intensity may be converted to electrical signal using appropriate software  
30 (e.g., Genotyper™ and Sequence Navigator™, Perkin Elmer), and the entire process from loading of samples to computer analysis and electronic data display may be computer controlled. Capillary electrophoresis is especially preferable for the sequencing of small

pieces of DNA which might be present in limited amounts in a particular sample.

In another embodiment of the invention, polynucleotide sequences or fragments thereof which encode CaBP may be used in recombinant DNA molecules to direct expression of CaBP, or fragments or functional equivalents thereof, in appropriate host  
5 cells. Due to the inherent degeneracy of the genetic code, other DNA sequences which encode substantially the same or a functionally equivalent amino acid sequence may be produced, and these sequences may be used to clone and express CaBP.

As will be understood by those of skill in the art, it may be advantageous to produce CaBP-encoding nucleotide sequences possessing non-naturally occurring codons.  
10 For example, codons preferred by a particular prokaryotic or eukaryotic host can be selected to increase the rate of protein expression or to produce an RNA transcript having desirable properties, such as a half-life which is longer than that of a transcript generated from the naturally occurring sequence.

The nucleotide sequences of the present invention can be engineered using  
15 methods generally known in the art in order to alter CaBP-encoding sequences for a variety of reasons including, but not limited to, alterations which modify the cloning, processing, and/or expression of the gene product. DNA shuffling by random fragmentation and PCR reassembly of gene fragments and synthetic oligonucleotides may be used to engineer the nucleotide sequences. For example, site-directed mutagenesis may  
20 be used to insert new restriction sites, alter glycosylation patterns, change codon preference, produce splice variants, introduce mutations, and so forth.

In another embodiment of the invention, natural, modified, or recombinant nucleic acid sequences encoding CaBP may be ligated to a heterologous sequence to encode a fusion protein. For example, to screen peptide libraries for inhibitors of CaBP activity, it  
25 may be useful to encode a chimeric CaBP protein that can be recognized by a commercially available antibody. A fusion protein may also be engineered to contain a cleavage site located between the CaBP encoding sequence and the heterologous protein sequence, so that CaBP may be cleaved and purified away from the heterologous moiety.

In another embodiment, sequences encoding CaBP may be synthesized, in whole  
30 or in part, using chemical methods well known in the art. (See, e.g., Caruthers, M.H. et al. (1980) Nucl. Acids Res. Symp. Ser. 215-223, and Horn, T. et al. (1980) Nucl. Acids Res. Symp. Ser. 225-232.) Alternatively, the protein itself may be produced using chemical



methods to synthesize the amino acid sequence of CaBP, or a fragment thereof. For example, peptide synthesis can be performed using various solid-phase techniques. (See, e.g., Roberge, J.Y. et al. (1995) Science 269:202-204.) Automated synthesis may be achieved using the ABI 431A Peptide Synthesizer (Perkin Elmer). Additionally, the amino acid sequence of CaBP, or any part thereof, may be altered during direct synthesis and/or combined with sequences from other proteins, or any part thereof, to produce a variant polypeptide.

The peptide may be substantially purified by preparative high performance liquid chromatography. (See, e.g., Chiez, R.M. and F.Z. Regnier (1990) Methods Enzymol. 182:392-421.) The composition of the synthetic peptides may be confirmed by amino acid analysis or by sequencing. (See, e.g., Creighton, T. (1984) Proteins, Structures and Molecular Properties, WH Freeman and Co., New York, NY.)

In order to express a biologically active CaBP, the nucleotide sequences encoding CaBP or derivatives thereof may be inserted into appropriate expression vector, i.e., a vector which contains the necessary elements for the transcription and translation of the inserted coding sequence.

Methods which are well known to those skilled in the art may be used to construct expression vectors containing sequences encoding CaBP and appropriate transcriptional and translational control elements. These methods include in vitro recombinant DNA techniques, synthetic techniques, and in vivo genetic recombination. (See, e.g., Sambrook, J. et al. (1989) Molecular Cloning, A Laboratory Manual, Cold Spring Harbor Press, Plainview, NY, ch. 4, 8, and 16-17; and Ausubel, F.M. et al. (1995, and periodic supplements) Current Protocols in Molecular Biology, John Wiley & Sons, New York, NY, ch. 9, 13, and 16.)

A variety of expression vector/host systems may be utilized to contain and express sequences encoding CaBP. These include, but are not limited to, microorganisms such as bacteria transformed with recombinant bacteriophage, plasmid, or cosmid DNA expression vectors; yeast transformed with yeast expression vectors; insect cell systems infected with virus expression vectors (e.g., baculovirus); plant cell systems transformed with virus expression vectors (e.g., cauliflower mosaic virus (CaMV) or tobacco mosaic virus (TMV)) or with bacterial expression vectors (e.g., Ti or pBR322 plasmids); or animal cell systems.

The invention is not limited by the host cell employed.

The "control elements" or "regulatory sequences" are those non-translated regions, e.g., enhancers, promoters, and 5' and 3' untranslated regions, of the vector and polynucleotide sequences encoding CaBP which interact with host cellular proteins to  
5 carry out transcription and translation. Such elements may vary in their strength and specificity. Depending on the vector system and host utilized, any number of suitable transcription and translation elements, including constitutive and inducible promoters, may be used. For example, when cloning in bacterial systems, inducible promoters, e.g., hybrid lacZ promoter of the Bluescript® phagemid (Stratagene, La Jolla, CA) or pSport1™  
10 plasmid (GIBCO/BRL), may be used. The baculovirus polyhedrin promoter may be used in insect cells. Promoters or enhancers derived from the genomes of plant cells (e.g., heat shock, RUBISCO, and storage protein genes) or from plant viruses (e.g., viral promoters or leader sequences) may be cloned into the vector. In mammalian cell systems, promoters from mammalian genes or from mammalian viruses are preferable. If it is  
15 necessary to generate a cell line that contains multiple copies of the sequence encoding CaBP, vectors based on SV40 or EBV may be used with an appropriate selectable marker.

In bacterial systems, a number of expression vectors may be selected depending upon the use intended for CaBP. For example, when large quantities of CaBP are needed for the induction of antibodies, vectors which direct high level expression of fusion  
20 proteins that are readily purified may be used. Such vectors include, but are not limited to, multifunctional E. coli cloning and expression vectors such as Bluescript® (Stratagene), in which the sequence encoding CaBP may be ligated into the vector in frame with sequences for the amino-terminal Met and the subsequent 7 residues of  $\beta$ -galactosidase so that a hybrid protein is produced, and pIN vectors. (See, e.g., Van Heeke, G. and S.M. Schuster  
25 (1989) J. Biol. Chem. 264:5503-5509.) pGEX vectors (Amersham Pharmacia Biotech, Uppsala, Sweden) may also be used to express foreign polypeptides as fusion proteins with glutathione S-transferase (GST). In general, such fusion proteins are soluble and can easily be purified from lysed cells by adsorption to glutathione-agarose beads followed by elution in the presence of free glutathione. Proteins made in such systems may be  
30 designed to include heparin, thrombin, or factor XA protease cleavage sites so that the cloned polypeptide of interest can be released from the GST moiety at will.

In the yeast Saccharomyces cerevisiae, a number of vectors containing constitutive

or inducible promoters, such as alpha factor, alcohol oxidase, and PGH, may be used. (See, e.g., Ausubel, supra; and Grant et al. (1987) *Methods Enzymol.* 153:516-544.)

In cases where plant expression vectors are used, the expression of sequences encoding CaBP may be driven by any of a number of promoters. For example, viral  
5 promoters such as the 35S and 19S promoters of CaMV may be used alone or in combination with the omega leader sequence from TMV. (Takamatsu, N. (1987) *EMBO J.* 6:307-311.) Alternatively, plant promoters such as the small subunit of RUBISCO or heat shock promoters may be used. (See, e.g., Coruzzi, G. et al. (1984) *EMBO J.* 3:1671-1680; Broglie, R. et al. (1984) *Science* 224:838-843; and Winter, J. et al. (1991) *Results Probl. Cell Differ.* 17:85-105.) These constructs can be introduced into plant cells  
10 by direct DNA transformation or pathogen-mediated transfection. Such techniques are described in a number of generally available reviews. (See, e.g., Hobbs, S. or Murry, L.E. in McGraw Hill Yearbook of Science and Technology (1992) McGraw Hill, New York, NY; pp. 191-196.)

15 An insect system may also be used to express CaBP. For example, in one such system, Autographa californica nuclear polyhedrosis virus (AcNPV) is used as a vector to express foreign genes in Spodoptera frugiperda cells or in Trichoplusia larvae. The sequences encoding CaBP may be cloned into a non-essential region of the virus, such as the polyhedrin gene, and placed under control of the polyhedrin promoter. Successful  
20 insertion of sequences encoding CaBP will render the polyhedrin gene inactive and produce recombinant virus lacking coat protein. The recombinant viruses may then be used to infect, for example, S. frugiperda cells or Trichoplusia larvae in which CaBP may be expressed. (See, e.g., Engelhard, E.K. et al. (1994) *Proc. Nat. Acad. Sci.* 91:3224-3227.)

25 In mammalian host cells, a number of viral-based expression systems may be utilized. In cases where an adenovirus is used as an expression vector, sequences encoding CaBP may be ligated into an adenovirus transcription/translation complex consisting of the late promoter and tripartite leader sequence. Insertion in a non-essential E1 or E3 region of the viral genome may be used to obtain a viable virus which is capable of  
30 expressing CaBP in infected host cells. (See, e.g., Logan, J. and T. Shenk (1984) *Proc. Natl. Acad. Sci.* 81:3655-3659.) In addition, transcription enhancers, such as the Rous sarcoma virus (RSV) enhancer, may be used to increase expression in mammalian host

cells.

Human artificial chromosomes (HACs) may also be employed to deliver larger fragments of DNA than can be contained and expressed in a plasmid. HACs of about 6 kb to 10 Mb are constructed and delivered via conventional delivery methods (liposomes, polycationic amino polymers, or vesicles) for therapeutic purposes.

Specific initiation signals may also be used to achieve more efficient translation of sequences encoding CaBP. Such signals include the ATG initiation codon and adjacent sequences. In cases where sequences encoding CaBP and its initiation codon and upstream sequences are inserted into the appropriate expression vector, no additional transcriptional or translational control signals may be needed. However, in cases where only coding sequence, or a fragment thereof, is inserted, exogenous translational control signals including the ATG initiation codon should be provided. Furthermore, the initiation codon should be in the correct reading frame to ensure translation of the entire insert. Exogenous translational elements and initiation codons may be of various origins, both natural and synthetic. The efficiency of expression may be enhanced by the inclusion of enhancers appropriate for the particular cell system used. (See, e.g., Scharf, D. et al. (1994) Results Probl. Cell Differ. 20:125-162.)

In addition, a host cell strain may be chosen for its ability to modulate expression of the inserted sequences or to process the expressed protein in the desired fashion. Such modifications of the polypeptide include, but are not limited to, acetylation, carboxylation, glycosylation, phosphorylation, lipidation, and acylation. Post-translational processing which cleaves a "prepro" form of the protein may also be used to facilitate correct insertion, folding, and/or function. Different host cells which have specific cellular machinery and characteristic mechanisms for post-translational activities (e.g., CHO, HeLa, MDCK, HEK293, and WI38), are available from the American Type Culture Collection (ATCC, Bethesda, MD) and may be chosen to ensure the correct modification and processing of the foreign protein.

For long term, high yield production of recombinant proteins, stable expression is preferred. For example, cell lines capable of stably expressing CaBP can be transformed using expression vectors which may contain viral origins of replication and/or endogenous expression elements and a selectable marker gene on the same or on a separate vector. Following the introduction of the vector, cells may be allowed to grow for about 1 to 2

days in enriched media before being switched to selective media. The purpose of the selectable marker is to confer resistance to selection, and its presence allows growth and recovery of cells which successfully express the introduced sequences. Resistant clones of stably transformed cells may be proliferated using tissue culture techniques appropriate to the cell type.

Any number of selection systems may be used to recover transformed cell lines. These include, but are not limited to, the herpes simplex virus thymidine kinase genes and adenine phosphoribosyltransferase genes, which can be employed in *tk* or *ap<sup>r</sup>* cells, respectively. (See, e.g., Wigler, M. et al. (1977) Cell 11:223-232; and Lowy, I. et al. (1980) Cell 22:817-823.) Also, antimetabolite, antibiotic, or herbicide resistance can be used as the basis for selection. For example, *dhfr* confers resistance to methotrexate; *npt* confers resistance to the aminoglycosides neomycin and G-418; and *als* or *pat* confer resistance to chlorsulfuron and phosphinotricin acetyltransferase, respectively. (See, e.g., Wigler, M. et al. (1980) Proc. Natl. Acad. Sci. 77:3567-3570; Colbere-Garapin, F. et al. (1981) J. Mol. Biol. 150:1-14; and Murry, supra.) Additional selectable genes have been described, e.g., *trpB*, which allows cells to utilize indole in place of tryptophan, or *hisD*, which allows cells to utilize histinol in place of histidine. (See, e.g., Hartman, S.C. and R.C. Mulligan (1988) Proc. Natl. Acad. Sci. 85:8047-8051.) Visible markers, e.g., anthocyanins,  $\beta$  glucuronidase and its substrate GUS, luciferase and its substrate luciferin may be used. Green fluorescent proteins (GFP) (Clontech, Palo Alto, CA) can also be used. These markers can be used not only to identify transformants, but also to quantify the amount of transient or stable protein expression attributable to a specific vector system. (See, e.g., Rhodes, C.A. et al. (1995) Methods Mol. Biol. 55:121-131.)

Although the presence/absence of marker gene expression suggests that the gene of interest is also present, the presence and expression of the gene may need to be confirmed. For example, if the sequence encoding CaBP is inserted within a marker gene sequence, transformed cells containing sequences encoding CaBP can be identified by the absence of marker gene function. Alternatively, a marker gene can be placed in tandem with a sequence encoding CaBP under the control of a single promoter. Expression of the marker gene in response to induction or selection usually indicates expression of the tandem gene as well.

Alternatively, host cells which contain the nucleic acid sequence encoding CaBP

and express CaBP may be identified by a variety of procedures known to those of skill in the art. These procedures include, but are not limited to, DNA-DNA or DNA-RNA hybridizations and protein bioassay or immunoassay techniques which include membrane, solution, or chip based technologies for the detection and/or quantification of nucleic acid  
5 or protein sequences.

The presence of polynucleotide sequences encoding CaBP can be detected by DNA-DNA or DNA-RNA hybridization or amplification using probes or fragments or fragments of polynucleotides encoding CaBP. Nucleic acid amplification based assays involve the use of oligonucleotides or oligomers based on the sequences encoding CaBP to  
10 detect transformants containing DNA or RNA encoding CaBP.

A variety of protocols for detecting and measuring the expression of CaBP, using either polyclonal or monoclonal antibodies specific for the protein, are known in the art. Examples of such techniques include enzyme-linked immunosorbent assays (ELISAs), radioimmunoassays (RIAs), and fluorescence activated cell sorting (FACS). A two-site,  
15 monoclonal-based immunoassay utilizing monoclonal antibodies reactive to two non-interfering epitopes on CaBP is preferred, but a competitive binding assay may be employed. These and other assays are well described in the art. (See, e.g., Hampton, R. et al. (1990) Serological Methods, a Laboratory Manual, APS Press, St Paul, MN, Section IV; and Maddox, D.E. et al. (1983) *J. Exp. Med.* 158:1211-1216).

A wide variety of labels and conjugation techniques are known by those skilled in the art and may be used in various nucleic acid and amino acid assays. Means for producing labeled hybridization or PCR probes for detecting sequences related to polynucleotides encoding CaBP include oligolabeling, nick translation, end-labeling, or PCR amplification using a labeled nucleotide. Alternatively, the sequences encoding  
25 CaBP, or any fragments thereof, may be cloned into a vector for the production of an mRNA probe. Such vectors are known in the art, are commercially available, and may be used to synthesize RNA probes in vitro by addition of an appropriate RNA polymerase such as T7, T3, or SP6 and labeled nucleotides. These procedures may be conducted using a variety of commercially available kits, such as those provided by Pharmacia & Upjohn  
30 (Kalamazoo, MI), Promega (Madison, WI), and U.S. Biochemical Corp. (Cleveland, OH). Suitable reporter molecules or labels which may be used for ease of detection include radionuclides, enzymes, fluorescent, chemiluminescent, or chromogenic agents, as well as

substrates, cofactors, inhibitors, magnetic particles, and the like.

Host cells transformed with nucleotide sequences encoding CaBP may be cultured under conditions suitable for the expression and recovery of the protein from cell culture. The protein produced by a transformed cell may be secreted or contained intracellularly depending on the sequence and/or the vector used. As will be understood by those of skill in the art, expression vectors containing polynucleotides which encode CaBP may be designed to contain signal sequences which direct secretion of CaBP through a prokaryotic or eukaryotic cell membrane. Other constructions may be used to join sequences encoding CaBP to nucleotide sequences encoding a polypeptide domain which will facilitate purification of soluble proteins. Such purification facilitating domains include, but are not limited to, metal chelating peptides such as histidine-tryptophan modules that allow purification on immobilized metals, protein A domains that allow purification on immobilized immunoglobulin, and the domain utilized in the FLAGS extension/affinity purification system (Immunex Corp., Seattle, WA). The inclusion of cleavable linker sequences, such as those specific for Factor XA or enterokinase (Invitrogen, San Diego, CA), between the purification domain and the CaBP encoding sequence may be used to facilitate purification. One such expression vector provides for expression of a fusion protein containing CaBP and a nucleic acid encoding 6 histidine residues preceding a thioredoxin or an enterokinase cleavage site. The histidine residues facilitate purification on immobilized metal ion affinity chromatography (IMAC). (See, e.g., Porath, J. et al. (1992) Prot. Exp. Purif. 3: 263-281.) The enterokinase cleavage site provides a means for purifying CaBP from the fusion protein. (See, e.g., Kroll, D.J. et al. (1993) DNA Cell Biol. 12:441-453.)

Fragments of CaBP may be produced not only by recombinant production, but also by direct peptide synthesis using solid-phase techniques. (See, e.g., Creighton, *supra* pp. 55-60.) Protein synthesis may be performed by manual techniques or by automation. Automated synthesis may be achieved, for example, using the Applied Biosystems 431A Peptide Synthesizer (Perkin Elmer). Various fragments of CaBP may be synthesized separately and then combined to produce the full length molecule.

#### THERAPEUTICS

Chemical and structural homology exists between CaBPs of the present invention

and other calcium binding proteins. In addition, CaBPs are expressed in neoplastic, immunological, gastrointestinal, reproductive, nervous, secretory, and Alzheimer's disease tissues. Therefore, CaBPs appear to play a role in nervous, vesicle trafficking, developmental, neoplastic, immunological, and reproductive disorders.

5 Therefore, in one embodiment, CaBP or a fragment or derivative thereof may be administered to a subject to treat or prevent a nervous disorder. Such nervous disorders can include, but are not limited to, akathisia, Alzheimer's disease, amnesia, amyotrophic lateral sclerosis, bipolar disorder, catatonia, cerebral neoplasms, dementia, depression, diabetic neuropathy, Down's syndrome, tardive dyskinesia, dystonias, epilepsy, 10 Huntington's disease, peripheral neuropathy, multiple sclerosis, neurofibromatosis, Parkinson's disease, paranoid psychoses, postherpetic neuralgia, schizophrenia, and Tourette's disorder.

In another embodiment, a vector capable of expressing CaBP or a fragment or derivative thereof may be administered to a subject to treat or prevent a nervous disorder 15 including, but not limited to, those described above.

In a further embodiment, a pharmaceutical composition comprising a substantially purified CaBP in conjunction with a suitable pharmaceutical carrier may be administered to a subject to treat or prevent a nervous disorder including, but not limited to, those provided above.

20 In still another embodiment, an agonist which modulates the activity of CaBP may be administered to a subject to treat or prevent a nervous disorder including, but not limited to, those listed above.

In one embodiment, CaBP or a fragment or derivative thereof may be administered to a subject to treat or prevent a vesicle trafficking disorder. Such vesicle trafficking 25 disorders can include, but are not limited to, cystic fibrosis, glucose-galactose malabsorption syndrome, hypercholesterolemia, diabetes mellitus, diabetes insipidus, hyper- and hypoglycemia, Grave's disease, goiter, Cushing's disease, and Addison's disease; gastrointestinal disorders including ulcerative colitis, gastric and duodenal ulcers; other conditions associated with abnormal vesicle trafficking including AIDS; allergies 30 including hay fever, asthma, and urticaria (hives); autoimmune hemolytic anemia; proliferative glomerulonephritis; inflammatory bowel disease; multiple sclerosis; myasthenia gravis; rheumatoid and osteoarthritis; scleroderma; Chediak-Higashi and



Sjogren's syndromes; systemic lupus erythematosus; toxic shock syndrome; traumatic tissue damage; and viral, bacterial, fungal, helminth. and protozoal infections.

In another embodiment, a vector capable of expressing CaBP or a fragment or derivative thereof may be administered to a subject to treat or prevent a vesicle trafficking disorder including, but not limited to, those described above.

In a further embodiment, a pharmaceutical composition comprising a substantially purified CaBP in conjunction with a suitable pharmaceutical carrier may be administered to a subject to treat or prevent a vesicle trafficking disorder including, but not limited to, those provided above.

In still another embodiment, an agonist which modulates the activity of CaBP may be administered to a subject to treat or prevent a vesicle trafficking disorder including, but not limited to, those listed above.

In one embodiment, CaBP or a fragment or derivative thereof may be administered to a subject to treat or prevent a developmental disorder. The term "developmental disorder" refers to any disorder associated with development or function of a tissue, organ, or system of a subject (such as the brain, adrenal gland, kidney, skeletal or reproductive system). Such developmental disorders can include, but are not limited to, renal tubular acidosis, anemia, Cushing's syndrome, achondroplastic dwarfism, Duchenne and Becker muscular dystrophy, epilepsy, gonadal dysgenesis, WAGR syndrome, Smith-Magenis syndrome, myelodysplastic syndrome, hereditary mucoepithelial dysplasia, hereditary keratodermas, hereditary neuropathies such as Charcot-Marie-Tooth disease and neurofibromatosis, hypothyroidism, hydrocephalus, seizure disorders such as Sydenham's chorea and cerebral palsy, spinal bifida, and congenital glaucoma, cataract, and sensorineural hearing loss.

In another embodiment, a vector capable of expressing CaBP or a fragment or derivative thereof may be administered to a subject to treat or prevent a developmental disorder including, but not limited to, those described above.

In a further embodiment, a pharmaceutical composition comprising a substantially purified CaBP in conjunction with a suitable pharmaceutical carrier may be administered to a subject to treat or prevent a developmental disorder including, but not limited to, those provided above.

In still another embodiment, an agonist which modulates the activity of CaBP may

be administered to a subject to treat or prevent a developmental disorder including, but not limited to, those listed above.

In a further embodiment, an antagonist of CaBP may be administered to a subject to treat or prevent a neoplastic disorder. Such neoplastic disorders may include, but are not limited to, adenocarcinoma, leukemia, lymphoma, melanoma, myeloma, sarcoma, teratocarcinoma, and, in particular, cancers of the adrenal gland, bladder, bone, bone marrow, brain, breast, cervix, gall bladder, ganglia, gastrointestinal tract, heart, kidney, liver, lung, muscle, ovary, pancreas, parathyroid, penis, prostate, salivary glands, skin, spleen, testis, thymus, thyroid, and uterus. In one aspect, an antibody which specifically binds CaBP may be used directly as an antagonist or indirectly as a targeting or delivery mechanism for bringing a pharmaceutical agent to cells or tissue which express CaBP.

In an additional embodiment, a vector expressing the complement of the polynucleotide encoding CaBP may be administered to a subject to treat or prevent a neoplastic disorder including, but not limited to, those described above.

In a further embodiment, an antagonist of CaBP may be administered to a subject to treat or prevent an immunological disorder. Such immunological disorders may include, but are not limited to, AIDS, Addison's disease, adult respiratory distress syndrome, allergies, ankylosing spondylitis, amyloidosis, anemia, asthma, atherosclerosis, autoimmune hemolytic anemia, autoimmune thyroiditis, bronchitis, cholecystitis, contact dermatitis, Crohn's disease, atopic dermatitis, dermatomyositis, diabetes mellitus, emphysema, erythema nodosum, atrophic gastritis, glomerulonephritis, Goodpasture's syndrome, gout, Graves' disease, Hashimoto's thyroiditis, hypereosinophilia, irritable bowel syndrome, lupus erythematosus, multiple sclerosis, myasthenia gravis, myocardial or pericardial inflammation, osteoarthritis, osteoporosis, pancreatitis, polymyositis, rheumatoid arthritis, scleroderma, Sjögren's syndrome, systemic anaphylaxis, systemic lupus erythematosus, systemic sclerosis, ulcerative colitis, Werner syndrome, and complications of cancer, hemodialysis, and extracorporeal circulation; viral, bacterial, fungal, parasitic, protozoal, and helminthic infections; and trauma. In one aspect, an antibody which specifically binds CaBP may be used directly as an antagonist or indirectly as a targeting or delivery mechanism for bringing a pharmaceutical agent to cells or tissue which express CaBP.

In an additional embodiment, a vector expressing the complement of the

polynucleotide encoding CaBP may be administered to a subject to treat or prevent an immunological disorder including, but not limited to, those described above.

In a further embodiment, an antagonist of CaBP may be administered to a subject to treat or prevent a reproductive disorder. Such reproductive disorders may include, but are not limited to, disorders of prolactin production; infertility, including tubal disease, ovulatory defects, and endometriosis; disruptions of the estrous cycle, disruptions of the menstrual cycle, polycystic ovary syndrome, ovarian hyperstimulation syndrome, endometrial and ovarian tumors, autoimmune disorders, ectopic pregnancy, and teratogenesis; cancer of the breast, uterine fibroids, fibrocystic breast disease, galactorrhea; disruptions of spermatogenesis, abnormal sperm physiology, cancer of the testis, cancer of the prostate, benign prostatic hyperplasia, prostatitis, Peyronie's disease, carcinoma of the male breast and gynecomastia. In one aspect, an antibody which specifically binds CaBP may be used directly as an antagonist or indirectly as a targeting or delivery mechanism for bringing a pharmaceutical agent to cells or tissue which express CaBP.

In an additional embodiment, a vector expressing the complement of the polynucleotide encoding CaBP may be administered to a subject to treat or prevent a reproductive disorder including, but not limited to, those described above.

In other embodiments, any of the proteins, antagonists, antibodies, agonists, complementary sequences, or vectors of the invention may be administered in combination with other appropriate therapeutic agents. Selection of the appropriate agents for use in combination therapy may be made by one of ordinary skill in the art, according to conventional pharmaceutical principles. The combination of therapeutic agents may act synergistically to effect the treatment or prevention of the various disorders described above. Using this approach, one may be able to achieve therapeutic efficacy with lower dosages of each agent, thus reducing the potential for adverse side effects.

An antagonist of CaBP may be produced using methods which are generally known in the art. In particular, purified CaBP may be used to produce antibodies or to screen libraries of pharmaceutical agents to identify those which specifically bind CaBP. Antibodies to CaBP may also be generated using methods that are well known in the art. Such antibodies may include, but are not limited to, polyclonal, monoclonal, chimeric, and single chain antibodies, Fab fragments, and fragments produced by a Fab expression library. Neutralizing antibodies (i.e., those which inhibit dimer formation) are especially

preferred for therapeutic use.

For the production of antibodies, various hosts including goats, rabbits, rats, mice, humans, and others may be immunized by injection with CaBP or with any fragment or oligopeptide thereof which has immunogenic properties. Depending on the host species, various adjuvants may be used to increase immunological response. Such adjuvants include, but are not limited to, Freund's, mineral gels such as aluminum hydroxide, and surface active substances such as lysolecithin, pluronic polyols, polyanions, peptides, oil emulsions, KLH, and dinitrophenol. Among adjuvants used in humans, BCG (bacilli Calmette-Guerin) and Corynebacterium parvum are especially preferable.

It is preferred that the oligopeptides, peptides, or fragments used to induce antibodies to CaBP have an amino acid sequence consisting of at least about 5 amino acids, and, more preferably, of at least about 10 amino acids. It is also preferable that these oligopeptides, peptides, or fragments are identical to a portion of the amino acid sequence of the natural protein and contain the entire amino acid sequence of a small, naturally occurring molecule. Short stretches of CaBP amino acids may be fused with those of another protein, such as KLH, and antibodies to the chimeric molecule may be produced.

Monoclonal antibodies to CaBP may be prepared using any technique which provides for the production of antibody molecules by continuous cell lines in culture. These include, but are not limited to, the hybridoma technique, the human B-cell hybridoma technique, and the EBV-hybridoma technique. (See, e.g., Kohler, G. et al. (1975) Nature 256:495-497; Kozbor, D. et al. (1985) J. Immunol. Methods 81:31-42; Cote, R.J. et al. (1983) Proc. Natl. Acad. Sci. 80:2026-2030; and Cole, S.P. et al. (1984) Mol. Cell Biol. 62:109-120.)

In addition, techniques developed for the production of "chimeric antibodies," such as the splicing of mouse antibody genes to human antibody genes to obtain a molecule with appropriate antigen specificity and biological activity, can be used. (See, e.g., Morrison, S.L. et al. (1984) Proc. Natl. Acad. Sci. 81:6851-6855; Neuberger, M.S. et al. (1984) Nature 312:604-608; and Takeda, S. et al. (1985) Nature 314:452-454.) Alternatively, techniques described for the production of single chain antibodies may be adapted, using methods known in the art, to produce CaBP-specific single chain antibodies. Antibodies with related specificity, but of distinct idiotypic composition, may

be generated by chain shuffling from random combinatorial immunoglobulin libraries.

(See, e.g., Burton D.R. (1991) Proc. Natl. Acad. Sci. 88:10134-10137.)

Antibodies may also be produced by inducing in vivo production in the lymphocyte population or by screening immunoglobulin libraries or panels of highly

5 specific binding reagents as disclosed in the literature. (See, e.g., Orlandi, R. et al. (1989) Proc. Natl. Acad. Sci. 86: 3833-3837; and Winter, G. et al. (1991) Nature 349:293-299.)

Antibody fragments which contain specific binding sites for CaBP may also be generated. For example, such fragments include, but are not limited to, F(ab')<sub>2</sub> fragments produced by pepsin digestion of the antibody molecule and Fab fragments generated by  
10 reducing the disulfide bridges of the F(ab')<sub>2</sub> fragments. Alternatively, Fab expression libraries may be constructed to allow rapid and easy identification of monoclonal Fab fragments with the desired specificity. (See, e.g., Huse, W.D. et al. (1989) Science 246:1275-1281.)

Various immunoassays may be used for screening to identify antibodies having the  
15 desired specificity. Numerous protocols for competitive binding or immunoradiometric assays using either polyclonal or monoclonal antibodies with established specificities are well known in the art. Such immunoassays typically involve the measurement of complex formation between CaBP and its specific antibody. A two-site, monoclonal-based immunoassay utilizing monoclonal antibodies reactive to two non-interfering CaBP  
20 epitopes is preferred, but a competitive binding assay may also be employed. (Maddox, supra.)

In another embodiment of the invention, the polynucleotides encoding CaBP, or any fragment or complement thereof, may be used for therapeutic purposes. In one aspect, the complement of the polynucleotide encoding CaBP may be used in situations in which  
25 it would be desirable to block the transcription of the mRNA. In particular, cells may be transformed with sequences complementary to polynucleotides encoding CaBP. Thus, complementary molecules or fragments may be used to modulate CaBP activity, or to achieve regulation of gene function. Such technology is now well known in the art, and sense or antisense oligonucleotides or larger fragments can be designed from various  
30 locations along the coding or control regions of sequences encoding CaBP.

Expression vectors derived from retroviruses, adenoviruses, or herpes or vaccinia viruses, or from various bacterial plasmids, may be used for delivery of nucleotide

sequences to the targeted organ, tissue, or cell population. Methods which are well known to those skilled in the art can be used to construct vectors which will express nucleic acid sequences complementary to the polynucleotides of the gene encoding CaBP. (See, e.g., Sambrook, *supra*; and Ausubel, *supra*.)

5 Genes encoding CaBP can be turned off by transforming a cell or tissue with expression vectors which express high levels of a polynucleotide, or fragment thereof, encoding CaBP. Such constructs may be used to introduce untranslatable sense or antisense sequences into a cell. Even in the absence of integration into the DNA, such vectors may continue to transcribe RNA molecules until they are disabled by endogenous  
10 nucleases. Transient expression may last for a month or more with a non-replicating vector, and may last even longer if appropriate replication elements are part of the vector system.

As mentioned above, modifications of gene expression can be obtained by designing complementary sequences or antisense molecules (DNA, RNA, or PNA) to the  
15 control, 5', or regulatory regions of the gene encoding CaBP. Oligonucleotides derived from the transcription initiation site, e.g., between about positions -10 and +10 from the start site, are preferred. Similarly, inhibition can be achieved using triple helix base-pairing methodology. Triple helix pairing is useful because it causes inhibition of the ability of the double helix to open sufficiently for the binding of polymerases, transcription  
20 factors, or regulatory molecules. Recent therapeutic advances using triplex DNA have been described in the literature. (See, e.g., Gee, J.E. et al. (1994) in Huber, B.E. and B.I. Carr, Molecular and Immunologic Approaches, Futura Publishing Co., Mt. Kisco, NY, pp. 163-177.) A complementary sequence or antisense molecule may also be designed to block translation of mRNA by preventing the transcript from binding to ribosomes.

25 Ribozymes, enzymatic RNA molecules, may also be used to catalyze the specific cleavage of RNA. The mechanism of ribozyme action involves sequence-specific hybridization of the ribozyme molecule to complementary target RNA, followed by endonucleolytic cleavage. For example, engineered hammerhead motif ribozyme molecules may specifically and efficiently catalyze endonucleolytic cleavage of sequences  
30 encoding CaBP.

Specific ribozyme cleavage sites within any potential RNA target are initially identified by scanning the target molecule for ribozyme cleavage sites, including the

following sequences: GUA, GUU, and GUC. Once identified, short RNA sequences of between 15 and 20 ribonucleotides, corresponding to the region of the target gene containing the cleavage site, may be evaluated for secondary structural features which may render the oligonucleotide inoperable. The suitability of candidate targets may also be  
5 evaluated by testing accessibility to hybridization with complementary oligonucleotides using ribonuclease protection assays.

Complementary ribonucleic acid molecules and ribozymes of the invention may be prepared by any method known in the art for the synthesis of nucleic acid molecules. These include techniques for chemically synthesizing oligonucleotides such as solid phase  
10 phosphoramidite chemical synthesis. Alternatively, RNA molecules may be generated by in vitro and in vivo transcription of DNA sequences encoding CaBP. Such DNA sequences may be incorporated into a wide variety of vectors with suitable RNA polymerase promoters such as T7 or SP6. Alternatively, these cDNA constructs that synthesize complementary RNA, constitutively or inducibly, can be introduced into cell  
15 lines, cells, or tissues.

RNA molecules may be modified to increase intracellular stability and half-life. Possible modifications include, but are not limited to, the addition of flanking sequences at the 5' and/or 3' ends of the molecule, or the use of phosphorothioate or 2' O-methyl rather than phosphodiesterase linkages within the backbone of the molecule. This concept is  
20 inherent in the production of PNAs and can be extended in all of these molecules by the inclusion of nontraditional bases such as inosine, queosine, and wybutosine, as well as acetyl-, methyl-, thio-, and similarly modified forms of adenine, cytidine, guanine, thymine, and uridine which are not as easily recognized by endogenous endonucleases.

Many methods for introducing vectors into cells or tissues are available and  
25 equally suitable for use in vivo, in vitro, and ex vivo. For ex vivo therapy, vectors may be introduced into stem cells taken from the patient and clonally propagated for autologous transplant back into that same patient. Delivery by transfection, by liposome injections, or by polycationic amino polymers may be achieved using methods which are well known in the art. (See, e.g., Goldman, C.K. et al. (1997) Nature Biotechnology 15:462-466.)

30 Any of the therapeutic methods described above may be applied to any subject in need of such therapy, including, for example, mammals such as dogs, cats, cows, horses, rabbits, monkeys, and most preferably, humans.

An additional embodiment of the invention relates to the administration of a pharmaceutical or sterile composition, in conjunction with a pharmaceutically acceptable carrier, for any of the therapeutic effects discussed above. Such pharmaceutical compositions may consist of CaBP, antibodies to CaBP, and mimetics, agonists, 5 antagonists, or inhibitors of CaBP. The compositions may be administered alone or in combination with at least one other agent, such as a stabilizing compound, which may be administered in any sterile, biocompatible pharmaceutical carrier including, but not limited to, saline, buffered saline, dextrose, and water. The compositions may be administered to a patient alone, or in combination with other agents, drugs, or hormones.

10 The pharmaceutical compositions utilized in this invention may be administered by any number of routes including, but not limited to, oral, intravenous, intramuscular, intra-arterial, intramedullary, intrathecal, intraventricular, transdermal, subcutaneous, intraperitoneal, intranasal, enteral, topical, sublingual, or rectal means.

In addition to the active ingredients, these pharmaceutical compositions may 15 contain suitable pharmaceutically-acceptable carriers comprising excipients and auxiliaries which facilitate processing of the active compounds into preparations which can be used pharmaceutically. Further details on techniques for formulation and administration may be found in the latest edition of Remington's Pharmaceutical Sciences (Maack Publishing Co., Easton, PA).

20 Pharmaceutical compositions for oral administration can be formulated using pharmaceutically acceptable carriers well known in the art in dosages suitable for oral administration. Such carriers enable the pharmaceutical compositions to be formulated as tablets, pills, dragees, capsules, liquids, gels, syrups, slurries, suspensions, and the like, for ingestion by the patient.

25 Pharmaceutical preparations for oral use can be obtained through combining active compounds with solid excipient and processing the resultant mixture of granules (optionally, after grinding) to obtain tablets or dragee cores. Suitable auxiliaries can be added, if desired. Suitable excipients include carbohydrate or protein fillers, such as sugars, including lactose, sucrose, mannitol, and sorbitol; starch from corn, wheat, rice, 30 potato, or other plants; cellulose, such as methyl cellulose, hydroxypropylmethyl-cellulose, or sodium carboxymethylcellulose; gums, including arabic and tragacanth; and proteins, such as gelatin and collagen. If desired, disintegrating



or solubilizing agents may be added, such as the cross-linked polyvinyl pyrrolidone, agar, and alginic acid or a salt thereof, such as sodium alginate.

Dragee cores may be used in conjunction with suitable coatings, such as concentrated sugar solutions, which may also contain gum arabic, talc,

5 polyvinylpyrrolidone, carbopol gel, polyethylene glycol, and/or titanium dioxide, lacquer solutions, and suitable organic solvents or solvent mixtures. Dyestuffs or pigments may be added to the tablets or dragee coatings for product identification or to characterize the quantity of active compound, i.e., dosage.

Pharmaceutical preparations which can be used orally include push-fit capsules  
10 made of gelatin, as well as soft, sealed capsules made of gelatin and a coating, such as glycerol or sorbitol. Push-fit capsules can contain active ingredients mixed with fillers or binders, such as lactose or starches, lubricants, such as talc or magnesium stearate, and, optionally, stabilizers. In soft capsules, the active compounds may be dissolved or suspended in suitable liquids, such as fatty oils, liquid, or liquid polyethylene glycol with  
15 or without stabilizers.

Pharmaceutical formulations suitable for parenteral administration may be formulated in aqueous solutions, preferably in physiologically compatible buffers such as Hanks's solution, Ringer's solution, or physiologically buffered saline. Aqueous injection suspensions may contain substances which increase the viscosity of the suspension, such  
20 as sodium carboxymethyl cellulose, sorbitol, or dextran. Additionally, suspensions of the active compounds may be prepared as appropriate oily injection suspensions. Suitable lipophilic solvents or vehicles include fatty oils, such as sesame oil, or synthetic fatty acid esters, such as ethyl oleate, triglycerides, or liposomes. Non-lipid polycationic amino polymers may also be used for delivery. Optionally, the suspension may also contain  
25 suitable stabilizers or agents to increase the solubility of the compounds and allow for the preparation of highly concentrated solutions.

For topical or nasal administration, penetrants appropriate to the particular barrier to be permeated are used in the formulation. Such penetrants are generally known in the art.

30 The pharmaceutical compositions of the present invention may be manufactured in a manner that is known in the art, e.g., by means of conventional mixing, dissolving, granulating, dragee-making, levigating, emulsifying, encapsulating, entrapping, or

lyophilizing processes.

The pharmaceutical composition may be provided as a salt and can be formed with many acids, including but not limited to, hydrochloric, sulfuric, acetic, lactic, tartaric, malic, and succinic acid. Salts tend to be more soluble in aqueous or other protonic solvents than are the corresponding free base forms. In other cases, the preferred preparation may be a lyophilized powder which may contain any or all of the following: 1 mM to 50 mM histidine, 0.1% to 2% sucrose, and 2% to 7% mannitol, at a pH range of 4.5 to 5.5, that is combined with buffer prior to use.

After pharmaceutical compositions have been prepared, they can be placed in an appropriate container and labeled for treatment of an indicated condition. For administration of CaBP, such labeling would include amount, frequency, and method of administration.

Pharmaceutical compositions suitable for use in the invention include compositions wherein the active ingredients are contained in an effective amount to achieve the intended purpose. The determination of an effective dose is well within the capability of those skilled in the art.

For any compound, the therapeutically effective dose can be estimated initially either in cell culture assays, e.g., of neoplastic cells or in animal models such as mice, rats, rabbits, dogs, or pigs. An animal model may also be used to determine the appropriate concentration range and route of administration. Such information can then be used to determine useful doses and routes for administration in humans.

A therapeutically effective dose refers to that amount of active ingredient, for example CaBP or fragments thereof, antibodies of CaBP, and agonists, antagonists or inhibitors of CaBP, which ameliorates the symptoms or condition. Therapeutic efficacy and toxicity may be determined by standard pharmaceutical procedures in cell cultures or with experimental animals, such as by calculating the  $ED_{50}$  (the dose therapeutically effective in 50% of the population) or  $LD_{50}$  (the dose lethal to 50% of the population) statistics. The dose ratio of therapeutic to toxic effects is the therapeutic index, and it can be expressed as the  $ED_{50}/LD_{50}$  ratio. Pharmaceutical compositions which exhibit large therapeutic indices are preferred. The data obtained from cell culture assays and animal studies are used to formulate a range of dosage for human use. The dosage contained in such compositions is preferably within a range of circulating concentrations that includes

the ED<sub>50</sub> with little or no toxicity. The dosage varies within this range depending upon the dosage form employed, the sensitivity of the patient, and the route of administration.

The exact dosage will be determined by the practitioner, in light of factors related to the subject requiring treatment. Dosage and administration are adjusted to provide  
5 sufficient levels of the active moiety or to maintain the desired effect. Factors which may be taken into account include the severity of the disease state, the general health of the subject, the age, weight, and gender of the subject, time and frequency of administration, drug combination(s), reaction sensitivities, and response to therapy. Long-acting pharmaceutical compositions may be administered every 3 to 4 days, every week, or  
10 biweekly depending on the half-life and clearance rate of the particular formulation.

Normal dosage amounts may vary from about 0.1  $\mu$ g to 100,000  $\mu$ g, up to a total dose of about 1 gram, depending upon the route of administration. Guidance as to particular dosages and methods of delivery is provided in the literature and generally available to practitioners in the art. Those skilled in the art will employ different  
15 formulations for nucleotides than for proteins or their inhibitors. Similarly, delivery of polynucleotides or polypeptides will be specific to particular cells, conditions, locations, etc.

#### DIAGNOSTICS

20 In another embodiment, antibodies which specifically bind CaBP may be used for the diagnosis of disorders characterized by expression of CaBP, or in assays to monitor patients being treated with CaBP or agonists, antagonists, or inhibitors of CaBP.

Antibodies useful for diagnostic purposes may be prepared in the same manner as described above for therapeutics. Diagnostic assays for CaBP include methods which  
25 utilize the antibody and a label to detect CaBP in human body fluids or in extracts of cells or tissues. The antibodies may be used with or without modification, and may be labeled by covalent or non-covalent attachment of a reporter molecule. A wide variety of reporter molecules, several of which are described above, are known in the art and may be used.

A variety of protocols for measuring CaBP, including ELISAs, RIAs, and FACS,  
30 are known in the art and provide a basis for diagnosing altered or abnormal levels of CaBP expression. Normal or standard values for CaBP expression are established by combining body fluids or cell extracts taken from normal mammalian subjects, preferably human,

with antibody to CaBP under conditions suitable for complex formation. The amount of standard complex formation may be quantitated by various methods, preferably by photometric means. Quantities of CaBP expressed in subject, control, and disease samples from biopsied tissues are compared with the standard values. Deviation between standard  
5 and subject values establishes the parameters for diagnosing disease.

In another embodiment of the invention, the polynucleotides encoding CaBP may be used for diagnostic purposes. The polynucleotides which may be used include oligonucleotide sequences, complementary RNA and DNA molecules, and PNAs. The polynucleotides may be used to detect and quantitate gene expression in biopsied tissues in  
10 which expression of CaBP may be correlated with disease. The diagnostic assay may be used to determine absence, presence, and excess expression of CaBP, and to monitor regulation of CaBP levels during therapeutic intervention.

In one aspect, hybridization with PCR probes which are capable of detecting polynucleotide sequences, including genomic sequences, encoding CaBP or closely related  
15 molecules may be used to identify nucleic acid sequences which encode CaBP. The specificity of the probe, whether it is made from a highly specific region, e.g., the 5' regulatory region, or from a less specific region, e.g., a conserved motif, and the stringency of the hybridization or amplification (maximal, high, intermediate, or low), will determine whether the probe identifies only naturally occurring sequences encoding CaBP,  
20 alleles, or related sequences.

Probes may also be used for the detection of related sequences, and should preferably have at least 50% sequence identity to any of the CaBP encoding sequences. The hybridization probes of the subject invention may be DNA or RNA and may be derived from the sequences of SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, or from  
25 genomic sequences including promoters, enhancers, and introns of the CaBP gene.

Means for producing specific hybridization probes for DNAs encoding CaBP include the cloning of polynucleotide sequences encoding CaBP or CaBP derivatives into vectors for the production of mRNA probes. Such vectors are known in the art, are commercially available, and may be used to synthesize RNA probes *in vitro* by means of  
30 the addition of the appropriate RNA polymerases and the appropriate labeled nucleotides. Hybridization probes may be labeled by a variety of reporter groups, for example, by radionuclides such as  $^{32}\text{P}$  or  $^{35}\text{S}$ , or by enzymatic labels, such as alkaline phosphatase

coupled to the probe via avidin/biotin coupling systems, and the like.

Polynucleotide sequences encoding CaBP may be used for the diagnosis of a disorder associated with expression of CaBP. Examples of such a disorder include, but are not limited to, a nervous disorder such as, akathisia, Alzheimer's disease, amnesia, amyotrophic lateral sclerosis, bipolar disorder, catatonia, cerebral neoplasms, dementia, depression, diabetic neuropathy, Down's syndrome, tardive dyskinesia, dystonias, epilepsy, Huntington's disease, peripheral neuropathy, multiple sclerosis, neurofibromatosis, Parkinson's disease, paranoid psychoses, postherpetic neuralgia, schizophrenia, and Tourette's disorder; a vesicle trafficking disorder such as, cystic fibrosis, glucose-galactose malabsorption syndrome, hypercholesterolemia, diabetes mellitus, diabetes insipidus, hyper- and hypoglycemia, Grave's disease, goiter, Cushing's disease, and Addison's disease; gastrointestinal disorders including ulcerative colitis, gastric and duodenal ulcers; other conditions associated with abnormal vesicle trafficking including AIDS; allergies including hay fever, asthma, and urticaria (hives); autoimmune hemolytic anemia; proliferative glomerulonephritis; inflammatory bowel disease; multiple sclerosis; myasthenia gravis; rheumatoid and osteoarthritis; scleroderma; Chediak-Higashi and Sjogren's syndromes; systemic lupus erythematosus; toxic shock syndrome; traumatic tissue damage; and viral, bacterial, fungal, helminth, and protozoal infections; a developmental disorder such as, renal tubular acidosis, anemia, Cushing's syndrome, achondroplastic dwarfism, Duchenne and Becker muscular dystrophy, epilepsy, gonadal dysgenesis, WAGR syndrome, Smith-Magenis syndrome, myelodysplastic syndrome, hereditary mucoepithelial dysplasia, hereditary keratodermas, hereditary neuropathies such as Charcot-Marie-Tooth disease and neurofibromatosis, hypothyroidism, hydrocephalus, seizure disorders such as Sydenham's chorea and cerebral palsy, spinal bifida, and congenital glaucoma, cataract, and sensorineural hearing loss; a neoplastic disorder such as, adenocarcinoma, leukemia, lymphoma, melanoma, myeloma, sarcoma, teratocarcinoma, and, in particular, cancers of the adrenal gland, bladder, bone, bone marrow, brain, breast, cervix, gall bladder, ganglia, gastrointestinal tract, heart, kidney, liver, lung, muscle, ovary, pancreas, parathyroid, penis, prostate, salivary glands, skin, spleen, testis, thymus, thyroid, and uterus; an immunological disorder such as, AIDS, Addison's disease, adult respiratory distress syndrome, allergies, ankylosing spondylitis, amyloidosis, anemia, asthma, atherosclerosis, autoimmune hemolytic anemia, autoimmune

thyroiditis, bronchitis, cholecystitis, contact dermatitis, Crohn's disease, atopic dermatitis, dermatomyositis, diabetes mellitus, emphysema, erythema nodosum, atrophic gastritis, glomerulonephritis, Goodpasture's syndrome, gout, Graves' disease, Hashimoto's thyroiditis, hypereosinophilia, irritable bowel syndrome, lupus erythematosus, multiple  
5 sclerosis, myasthenia gravis, myocardial or pericardial inflammation, osteoarthritis, osteoporosis, pancreatitis, polymyositis, rheumatoid arthritis, scleroderma, Sjögren's syndrome, systemic anaphylaxis, systemic lupus erythematosus, systemic sclerosis, ulcerative colitis, Werner syndrome, and complications of cancer, hemodialysis, and extracorporeal circulation; viral, bacterial, fungal, parasitic, protozoal, and helminthic  
10 infections; and trauma; and a reproductive disorder such as, disorders of prolactin production; infertility, including tubal disease, ovulatory defects, and endometriosis; disruptions of the estrous cycle, disruptions of the menstrual cycle, polycystic ovary syndrome, ovarian hyperstimulation syndrome, endometrial and ovarian tumors, autoimmune disorders, ectopic pregnancy, and teratogenesis; cancer of the breast, uterine  
15 fibroids, fibrocystic breast disease, galactorrhea; disruptions of spermatogenesis, abnormal sperm physiology, cancer of the testis, cancer of the prostate, benign prostatic hyperplasia, prostatitis, Peyronie's disease, carcinoma of the male breast and gynecomastia. The polynucleotide sequences encoding CaBP may be used in Southern or northern analysis, dot blot, or other membrane-based technologies; in PCR technologies; in dipstick, pin, and  
20 ELISA assays; and in microarrays utilizing fluids or tissues from patients to detect altered CaBP expression. Such qualitative or quantitative methods are well known in the art.

In a particular aspect, the nucleotide sequences encoding CaBP may be useful in assays that detect the presence of associated disorders, particularly those mentioned above. The nucleotide sequences encoding CaBP may be labeled by standard methods and added  
25 to a fluid or tissue sample from a patient under conditions suitable for the formation of hybridization complexes. After a suitable incubation period, the sample is washed and the signal is quantitated and compared with a standard value. If the amount of signal in the patient sample is significantly altered in comparison to a control sample then the presence of altered levels of nucleotide sequences encoding CaBP in the sample indicates the  
30 presence of the associated disorder. Such assays may also be used to evaluate the efficacy of a particular therapeutic treatment regimen in animal studies, in clinical trials, or to monitor the treatment of an individual patient.

In order to provide a basis for the diagnosis of a disorder associated with expression of CaBP, a normal or standard profile for expression is established. This may be accomplished by combining body fluids or cell extracts taken from normal subjects, either animal or human, with a sequence, or a fragment thereof, encoding CaBP, under  
5 conditions suitable for hybridization or amplification. Standard hybridization may be quantified by comparing the values obtained from normal subjects with values from an experiment in which a known amount of a substantially purified polynucleotide is used. Standard values obtained in this manner may be compared with values obtained from samples from patients who are symptomatic for a disorder. Deviation from standard  
10 values is used to establish the presence of a disorder.

Once the presence of a disorder is established and a treatment protocol is initiated, hybridization assays may be repeated on a regular basis to determine if the level of expression in the patient begins to approximate that which is observed in the normal subject. The results obtained from successive assays may be used to show the efficacy of  
15 treatment over a period ranging from several days to months.

With respect to cancer, the presence of a relatively high amount of transcript in biopsied tissue from an individual may indicate a predisposition for the development of the disease, or may provide a means for detecting the disease prior to the appearance of actual clinical symptoms. A more definitive diagnosis of this type may allow health  
20 professionals to employ preventative measures or aggressive treatment earlier thereby preventing the development or further progression of the cancer.

Additional diagnostic uses for oligonucleotides designed from the sequences encoding CaBP may involve the use of PCR. These oligomers may be chemically synthesized, generated enzymatically, or produced in vitro. Oligomers will preferably  
25 contain a fragment of a polynucleotide encoding CaBP, or a fragment of a polynucleotide complementary to the polynucleotide encoding CaBP, and will be employed under optimized conditions for identification of a specific gene or condition. Oligomers may also be employed under less stringent conditions for detection or quantitation of closely related DNA or RNA sequences.

30 Methods which may also be used to quantitate the expression of CaBP include radiolabeling or biotinylating nucleotides, coamplification of a control nucleic acid, and interpolating results from standard curves. (See, e.g., Melby, P.C. et al. (1993) J.

Immunol. Methods 159:235-244; and Duplaa, C. et al. (1993) Anal. Biochem. 229-236.)

The speed of quantitation of multiple samples may be accelerated by running the assay in an ELISA format where the oligomer of interest is presented in various dilutions and a spectrophotometric or colorimetric response gives rapid quantitation.

5 In further embodiments, oligonucleotides or longer fragments derived from any of the polynucleotide sequences described herein may be used as targets in a microarray. The microarray can be used to monitor the expression level of large numbers of genes simultaneously and to identify genetic variants, mutations, and polymorphisms. This information may be used to determine gene function, to understand the genetic basis of a  
10 disorder, to diagnose a disorder, and to develop and monitor the activities of therapeutic agents.

Microarrays may be prepared, used, and analyzed using methods known in the art. (See, e.g., Brennan, T.M. et al. (1995) U.S. Patent No. 5,474,796; Schena, M. et al. (1996) Proc. Natl. Acad. Sci. 93:10614-10619; Baldeschweiler et al. (1995) PCT application  
15 WO95/251116; Shalon, D. et al. (1995) PCT application WO95/35505; Heller, R.A. et al. (1997) Proc. Natl. Acad. Sci. 94:2150-2155; and Heller, M.J. et al. (1997) U.S. Patent No. 5,605,662.)

In another embodiment of the invention, nucleic acid sequences encoding CaBP may be used to generate hybridization probes useful in mapping the naturally occurring  
20 genomic sequence. The sequences may be mapped to a particular chromosome, to a specific region of a chromosome, or to artificial chromosome constructions, e.g., human artificial chromosomes (HACs), yeast artificial chromosomes (YACs), bacterial artificial chromosomes (BACs), bacterial P1 constructions, or single chromosome cDNA libraries. (See, e.g., Price, C.M. (1993) Blood Rev. 7:127-134; and Trask, B.J. (1991) Trends Genet.  
25 7:149-154.)

Fluorescent in situ hybridization (FISH) may be correlated with other physical chromosome mapping techniques and genetic map data. (See, e.g., Heinz-Ulrich, et al. (1995) in Meyers, R.A. (ed.) Molecular Biology and Biotechnology, VCH Publishers New York, NY, pp. 965-968.) Examples of genetic map data can be found in various scientific  
30 journals or at the Online Mendelian Inheritance in Man (OMIM) site. Correlation between the location of the gene encoding CaBP on a physical chromosomal map and a specific disorder, or a predisposition to a specific disorder, may help define the region of DNA



associated with that disorder. The nucleotide sequences of the invention may be used to detect differences in gene sequences among normal, carrier, and affected individuals.

In situ hybridization of chromosomal preparations and physical mapping techniques, such as linkage analysis using established chromosomal markers, may be used  
5 for extending genetic maps. Often the placement of a gene on the chromosome of another mammalian species, such as mouse, may reveal associated markers even if the number or arm of a particular human chromosome is not known. New sequences can be assigned to chromosomal arms by physical mapping. This provides valuable information to investigators searching for disease genes using positional cloning or other gene discovery  
10 techniques. Once the disease or syndrome has been crudely localized by genetic linkage to a particular genomic region, e.g., AT to 11q22-23, any sequences mapping to that area may represent associated or regulatory genes for further investigation. (See, e.g., Gatti, R.A. et al. (1988) Nature 336:577-580.) The nucleotide sequence of the subject invention may also be used to detect differences in the chromosomal location due to translocation,  
15 inversion, etc., among normal, carrier, or affected individuals.

In another embodiment of the invention, CaBP, its catalytic or immunogenic fragments, or oligopeptides thereof can be used for screening libraries of compounds in any of a variety of drug screening techniques. The fragment employed in such screening may be free in solution, affixed to a solid support, borne on a cell surface, or located  
20 intracellularly. The formation of binding complexes between CaBP and the agent being tested may be measured.

Another technique for drug screening provides for high throughput screening of compounds having suitable binding affinity to the protein of interest. (See, e.g., Geysen, et al. (1984) PCT application WO84/03564.) In this method, large numbers of different  
25 small test compounds are synthesized on a solid substrate, such as plastic pins or some other surface. The test compounds are reacted with CaBP, or fragments thereof, and washed. Bound CaBP is then detected by methods well known in the art. Purified CaBP can also be coated directly onto plates for use in the aforementioned drug screening techniques. Alternatively, non-neutralizing antibodies can be used to capture the peptide  
30 and immobilize it on a solid support.

In another embodiment, one may use competitive drug screening assays in which neutralizing antibodies capable of binding CaBP specifically compete with a test

compound for binding CaBP. In this manner, antibodies can be used to detect the presence of any peptide which shares one or more antigenic determinants with CaBP.

In additional embodiments, the nucleotide sequences which encode CaBP may be used in any molecular biology techniques that have yet to be developed, provided the new techniques rely on properties of nucleotide sequences that are currently known, including, but not limited to, such properties as the triplet genetic code and specific base pair interactions.

The examples below are provided to illustrate the subject invention and are not included for the purpose of limiting the invention.

10

## EXAMPLES

### I. cDNA Library Construction

The BRAINON01 normalized cDNA library was constructed from cancerous brain tissue obtained from a 26-year-old Caucasian male (specimen # 0003) during cerebral meningeal excision following diagnosis of grade 4 oligoastrocytoma localized in the right fronto-parietal part of the brain. Prior to surgery the patient was also diagnosed with hemiplegia, epilepsy, ptosis of eyelid, and common migraine. The frozen tissue was homogenized and lysed using a Brinkmann Homogenizer Polytron PT-3000 (Brinkmann Instruments, Westbury, NY) in guanidinium isothiocyanate solution. The lysate was extracted with acid phenol at pH 4.7 per Stratagene's RNA isolation protocol (Stratagene, Inc., San Diego, CA). The RNA was extracted with an equal volume of acid phenol, reprecipitated using 0.3 M sodium acetate and 2.5 volumes of ethanol, resuspended in DEPC-treated water, and treated with DNase for 25 min at 37°C. RNA extraction and precipitation were repeated as before. The mRNA was then isolated using the Qiagen Oligotex kit (QIAGEN, Inc.; Chatsworth, CA) and used to construct the cDNA library.

The mRNA was handled according to the recommended protocols in the SuperScript plasmid system (Catalog # 18248-013; GIBCO-BRL). cDNA synthesis was initiated with a NotI-oligo d(T) primer. Double-stranded cDNA was blunted, ligated to SalI adaptors, digested with NotI, and fractionated on a Sepharose CL4B column (Catalog # 275105-01; Pharmacia), and those cDNAs exceeding 400 bp were ligated into the NotI and SalI sites of the plasmid pSport I. The plasmid pSport I was subsequently transformed

into DH5 $\alpha$ <sup>TM</sup> competent cells (Catalog # 18258-012; GIBCO-BRL).

## II. Normalization, Isolation, and Sequencing of cDNA clones

4.9 x 10<sup>6</sup> independent clones of the BRAINON01 plasmid library in E. coli strain  
5 DH12S (Catalog # 18312-017, GIBCO-BRL) were grown in liquid culture under  
carbenicillin (25 mg/l) and methicillin (1 mg/ml) selection following transformation by  
electroporation. To reduce the number of excess cDNA copies according to their  
abundance levels in the library, the cDNA library was then normalized in a single round  
according to the procedure of Soares et al. (1994, Proc. Natl. Acad. Sci. 91:9928-9932),  
10 with the following modifications. The primer to template ratio in the primer extension  
reaction was increased from 2:1 to 10:1. The ddNTP concentration in this reaction was  
reduced to 150  $\mu$ M each ddNTP, allowing the generation of longer (400-1000 nt) primer  
extension products. The reannealing hybridization was extended from 13 to 48 hours. The  
single stranded DNA circles of the normalized library were purified by hydroxyapatite  
15 chromatography and converted to partially double-stranded by random priming, followed  
by electroporation into DH10B competent bacteria (GIBCO-BRL).

Plasmid DNA was released from the cells and purified using the REAL Prep 96  
plasmid kit (Catalog # 26173; QIAGEN, Inc.). The recommended protocol was employed  
except for the following changes: 1) the bacteria were cultured in 1 ml of sterile Terrific  
20 Broth (Catalog # 22711, GIBCO-BRL) with carbenicillin at 25 mg/l and glycerol at 0.4%;  
2) after inoculation, the cultures were incubated for 19 hours and at the end of incubation,  
the cells were lysed with 0.3 ml of lysis buffer; and 3) following isopropanol precipitation,  
the plasmid DNA pellet was resuspended in 0.1 ml of distilled water. After the last step in  
the protocol, samples were transferred to a 96-well block for storage at 4° C.

25 The cDNAs were sequenced by the method of Sanger et al. (1975, J. Mol. Biol.  
94:441), using a Hamilton Micro Lab 2200 (Hamilton, Reno, NV) in combination with  
Peltier Thermal Cyclers (PTC200 from MJ Research, Watertown, MA) and Applied  
Biosystems 377 DNA Sequencing Systems, and the reading frame determined.

### III. Homology Searching of cDNA Clones and Their Deduced Proteins

The nucleotide sequences and/or amino acid sequences of the Sequence Listing were used to query sequences in the GenBank, SwissProt, BLOCKS, and Pima II databases. These databases, which contain previously identified and annotated sequences.

5 were searched for regions of homology using BLAST (Basic Local Alignment Search Tool). (See, e.g., Altschul, S.F. (1993) J. Mol. Evol 36:290-300; and Altschul et al. (1990) J. Mol. Biol. 215:403-410.)

BLAST produced alignments of both nucleotide and amino acid sequences to determine sequence similarity. Because of the local nature of the alignments, BLAST was  
10 especially useful in determining exact matches or in identifying homologs which may be of prokaryotic (bacterial) or eukaryotic (animal, fungal, or plant) origin. Other algorithms could have been used when dealing with primary sequence patterns and secondary structure gap penalties. (See, e.g., Smith, T. et al. (1992) Protein Engineering 5:35-51.) The sequences disclosed in this application have lengths of at least 49 nucleotides and  
15 have no more than 12% uncalled bases (where N is recorded rather than A, C, G, or T).

The BLAST approach searched for matches between a query sequence and a database sequence. BLAST evaluated the statistical significance of any matches found, and reported only those matches that satisfy the user-selected threshold of significance. In this application, threshold was set at  $10^{-25}$  for nucleotides and  $10^{-8}$  for peptides.

20 Incyte nucleotide sequences were searched against the GenBank databases for primate (pri), rodent (rod), and other mammalian sequences (mam), and deduced amino acid sequences from the same clones were then searched against GenBank functional protein databases, mammalian (mamp), vertebrate (vrtp), and eukaryote (eukp), for homology.

25 Additionally, sequences identified from cDNA libraries may be analyzed to identify those gene sequences encoding conserved protein motifs using an appropriate analysis program, e.g., the Block 2 Bioanalysis Program (Incyte, Palo Alto, CA). This motif analysis program, based on sequence information contained in the Swiss-Prot Database and PROSITE, is a method of determining the function of uncharacterized  
30 proteins translated from genomic or cDNA sequences. (See, e.g., Bairoch, A. et al. (1997) Nucleic Acids Res. 25:217-221; and Attwood, T. K. et al. (1997) J. Chem. Inf. Comput. Sci. 37:417-424.) PROSITE may be used to identify common functional or structural

domains in divergent proteins. The method is based on weight matrices. Motifs identified by this method are then calibrated against the SWISS-PROT database in order to obtain a measure of the chance distribution of the matches.

In another alternative, Hidden Markov models (HMMs) may be used to find  
5 protein domains, each defined by a dataset of proteins known to have a common biological function. (See, e.g., Pearson, W.R. and D.J. Lipman (1988) Proc. Natl. Acad. Sci. 85:2444-2448; and Smith, T.F. and M.S. Waterman (1981) J. Mol. Biol. 147:195-197.) HMMs were initially developed to examine speech recognition patterns, but are now being used in a biological context to analyze protein and nucleic acid sequences as well as to  
10 model protein structure. (See, e.g., Krogh, A. et al. (1994) J. Mol. Biol. 235:1501-1531; and Collin, M. et al. (1993) Protein Sci. 2:305-314.) HMMs have a formal probabilistic basis and use position-specific scores for amino acids or nucleotides. The algorithm continues to incorporate information from newly identified sequences to increase its motif analysis capabilities.

15

#### IV. Northern Analysis

Northern analysis is a laboratory technique used to detect the presence of a transcript of a gene and involves the hybridization of a labeled nucleotide sequence to a membrane on which RNAs from a particular cell type or tissue have been bound. (See,  
20 e.g., Sambrook, *supra*, ch. 7; and Ausubel, *supra*, ch. 4 and 16.)

Analogous computer techniques applying BLAST are used to search for identical or related molecules in nucleotide databases such as GenBank or LIFESEQ™ database (Incyte Pharmaceuticals). This analysis is much faster than multiple membrane-based hybridizations. In addition, the sensitivity of the computer search can be modified to  
25 determine whether any particular match is categorized as exact or homologous.

The basis of the search is the product score, which is defined as:

$$\frac{\% \text{ sequence identity} \times \% \text{ maximum BLAST score}}{100}$$

The product score takes into account both the degree of similarity between two sequences  
30 and the length of the sequence match. For example, with a product score of 40, the match will be exact within a 1% to 2% error, and, with a product score of 70, the match will be exact. Homologous molecules are usually identified by selecting those which show

product scores between 15 and 40, although lower scores may identify related molecules.

The results of northern analysis are reported as a list of libraries in which the transcript encoding CaBP occurs. Abundance and percent abundance are also reported. Abundance directly reflects the number of times a particular transcript is represented in a cDNA library, and percent abundance is abundance divided by the total number of sequences examined in the cDNA library.

#### V. Extension of CaBP Encoding Polynucleotides

The nucleic acid sequences of Incyte Clones 2061917, 2287407, and 2379155 were used to design oligonucleotide primers for extending partial nucleotide sequences to full length. For each nucleic acid sequence, one primer was synthesized to initiate extension of an antisense polynucleotide, and the other was synthesized to initiate extension of a sense polynucleotide. Primers were used to facilitate the extension of the known sequence "outward" generating amplicons containing new unknown nucleotide sequence for the region of interest. The initial primers were designed from the cDNA using OLIGO 4.06 (National Biosciences, Plymouth, MN), or another appropriate program, to be about 22 to 30 nucleotides in length, to have a GC content of about 50% or more, and to anneal to the target sequence at temperatures of about 68°C to about 72°C. Any stretch of nucleotides which would result in hairpin structures and primer-primer dimerizations was avoided.

Selected human cDNA libraries (GIBCO/BRL) were used to extend the sequence. If more than one extension is necessary or desired, additional sets of primers are designed to further extend the known region.

High fidelity amplification was obtained by following the instructions for the XL-PCR kit (Perkin Elmer) and thoroughly mixing the enzyme and reaction mix. PCR was performed using the Peltier Thermal Cycler (PTC200; M.J. Research, Watertown, MA), beginning with 40 pmol of each primer and the recommended concentrations of all other components of the kit, with the following parameters:

|        |  |
|--------|--|
| Step 1 | 94° C for 1 min (initial denaturation)               |
| Step 2 | 65° C for 1 min                                      |
| Step 3 | 68° C for 6 min                                      |
| Step 4 | 94° C for 15 sec                                     |
| Step 5 | 65° C for 1 min                                      |
| Step 6 | 68° C for 7 min                                      |
| Step 7 | Repeat steps 4 through 6 for an additional 15 cycles |

- Step 8 94° C for 15 sec  
Step 9 65° C for 1 min  
Step 10 68° C for 7:15 min  
Step 11 Repeat steps 8 through 10 for an additional 12 cycles  
5 Step 12 72° C for 8 min  
Step 13 4° C (and holding)

A 5  $\mu$ l to 10  $\mu$ l aliquot of the reaction mixture was analyzed by electrophoresis on a low concentration (about 0.6% to 0.8%) agarose mini-gel to determine which reactions  
10 were successful in extending the sequence. Bands thought to contain the largest products were excised from the gel, purified using QIAQuick™ (QIAGEN Inc.), and trimmed of overhangs using Klenow enzyme to facilitate religation and cloning.

After ethanol precipitation, the products were redissolved in 13  $\mu$ l of ligation buffer, 1  $\mu$ l T4-DNA ligase (15 units) and 1  $\mu$ l T4 polynucleotide kinase were added, and  
15 the mixture was incubated at room temperature for 2 to 3 hours, or overnight at 16° C. Competent *E. coli* cells (in 40  $\mu$ l of appropriate media) were transformed with 3  $\mu$ l of ligation mixture and cultured in 80  $\mu$ l of SOC medium. (See, e.g., Sambrook, *supra*, Appendix A, p. 2.) After incubation for one hour at 37° C, the *E. coli* mixture was plated on Luria Bertani (LB) agar (See, e.g., Sambrook, *supra*, Appendix A, p. 1) containing  
20 carbenicillin (2x carb). The following day, several colonies were randomly picked from each plate and cultured in 150  $\mu$ l of liquid LB/2x Carb medium placed in an individual well of an appropriate commercially-available sterile 96-well microtiter plate. The following day, 5  $\mu$ l of each overnight culture was transferred into a non-sterile 96-well plate and, after dilution 1:10 with water, 5  $\mu$ l from each sample was transferred into a PCR  
25 array.

For PCR amplification, 18  $\mu$ l of concentrated PCR reaction mix (3.3x) containing 4 units of rTth DNA polymerase, a vector primer, and one or both of the gene specific primers used for the extension reaction were added to each well. Amplification was performed using the following conditions:

- 30 Step 1 94° C for 60 sec  
Step 2 94° C for 20 sec  
Step 3 55° C for 30 sec  
Step 4 72° C for 90 sec  
Step 5 Repeat steps 2 through 4 for an additional 29 cycles  
35 Step 6 72° C for 180 sec  
Step 7 4° C (and holding)

Aliquots of the PCR reactions were run on agarose gels together with molecular weight markers. The sizes of the PCR products were compared to the original partial cDNAs, and appropriate clones were selected, ligated into plasmid, and sequenced.

In like manner, the nucleotide sequences of SEQ ID NO:4, SEQ ID NO:5, and  
5 SEQ ID NO:6 are used to obtain 5' regulatory sequences using the procedure above, oligonucleotides designed for 5' extension, and an appropriate genomic library.

## VI. Labeling and Use of Individual Hybridization Probes

Hybridization probes derived from SEQ ID NO:4, SEQ ID NO:5, and SEQ ID  
10 NO:6 are employed to screen cDNAs, genomic DNAs, or mRNAs. Although the labeling of oligonucleotides, consisting of about 20 base pairs, is specifically described, essentially the same procedure is used with larger nucleotide fragments. Oligonucleotides are designed using state-of-the-art software such as OLIGO 4.06 (National Biosciences) and labeled by combining 50 pmol of each oligomer, 250  $\mu$ Ci of [ $\gamma$ - $^{32}$ P] adenosine  
15 triphosphate (Amersham, Chicago, IL), and T4 polynucleotide kinase (DuPont NEN®, Boston, MA). The labeled oligonucleotides are substantially purified using a Sephadex G-25 superfine resin column (Pharmacia & Upjohn, Kalamazoo, MI). An aliquot containing 10<sup>7</sup> counts per minute of the labeled probe is used in a typical membrane-based hybridization analysis of human genomic DNA digested with one of the following  
20 endonucleases: Ase I, Bgl II, Eco RI, Pst I, Xba I, or Pvu II (DuPont NEN, Boston, MA).

The DNA from each digest is fractionated on a 0.7 percent agarose gel and transferred to nylon membranes (Nytran Plus, Schleicher & Schuell, Durham, NH). Hybridization is carried out for 16 hours at 40°C. To remove nonspecific signals, blots are sequentially washed at room temperature under increasingly stringent conditions up to  
25 0.1 x saline sodium citrate and 0.5% sodium dodecyl sulfate. After XOMAT AR™ film (Kodak, Rochester, NY) is exposed to the blots to film for several hours, hybridization patterns are compared visually.

## VII. Microarrays

30 A chemical coupling procedure and an ink jet device can be used to synthesize array elements on the surface of a substrate. (See, e.g., Baldeschweiler, *supra*.) An array analogous to a dot or slot blot may also be used to arrange and link elements to the surface



of a substrate using thermal, UV, chemical, or mechanical bonding procedures. A typical array may be produced by hand or using available methods and machines and contain any appropriate number of elements. After hybridization, nonhybridized probes are removed and a scanner used to determine the levels and patterns of fluorescence. The degree of  
5 complementarity and the relative abundance of each probe which hybridizes to an element on the microarray may be assessed through analysis of the scanned images.

Full-length cDNAs, Expressed Sequence Tags (ESTs), or fragments thereof may comprise the elements of the microarray. Fragments suitable for hybridization can be selected using software well known in the art such as LASERGENE™. Full-length  
10 cDNAs, ESTs, or fragments thereof corresponding to one of the nucleotide sequences of the present invention, or selected at random from a cDNA library relevant to the present invention, are arranged on an appropriate substrate, e.g., a glass slide. The cDNA is fixed to the slide using, e.g., UV cross-linking followed by thermal and chemical treatments and subsequent drying. (See, e.g., Schena, M. et al. (1995) Science 270:467-470; and Shalon,  
15 D. et al. (1996) Genome Res. 6:639-645.) Fluorescent probes are prepared and used for hybridization to the elements on the substrate. The substrate is analyzed by procedures described above.

#### **VIII. Complementary Polynucleotides**

20 Sequences complementary to the CaBP-encoding sequences, or any parts thereof, are used to detect, decrease, or inhibit expression of naturally occurring CaBP. Although use of oligonucleotides comprising from about 15 to 30 base pairs is described, essentially the same procedure is used with smaller or with larger sequence fragments. Appropriate oligonucleotides are designed using Oligo 4.06 software and the coding sequence of  
25 CaBP. To inhibit transcription, a complementary oligonucleotide is designed from the most unique 5' sequence and used to prevent promoter binding to the coding sequence. To inhibit translation, a complementary oligonucleotide is designed to prevent ribosomal binding to the CaBP-encoding transcript.

#### **30 IX. Expression of CaBP**

Expression of CaBP is accomplished by subcloning the cDNA into an appropriate vector and transforming the vector into host cells. This vector contains an appropriate

promoter, e.g.,  $\beta$ -galactosidase, upstream of the cloning site, operably associated with the cDNA of interest. (See, e.g., Sambrook, supra, pp. 404-433; and Rosenberg, M. et al. (1983) Methods Enzymol. 101:123-138.)

Induction of an isolated, transformed bacterial strain with isopropyl beta-D-thiogalactopyranoside (IPTG) using standard methods produces a fusion protein which consists of the first 8 residues of  $\beta$ -galactosidase, about 5 to 15 residues of linker, and the full length protein. The signal residues direct the secretion of CaBP into bacterial growth media which can be used directly in the following assay for activity.

#### 10 X. Demonstration of CaBP Activity

The assay for human calcium-binding proteins is based upon the ability of CaBPs to down-regulate mitosis. CaBP can be expressed by transforming a mammalian cell line such as COS7, HeLa or CHO with an eukaryotic expression vector encoding CaBP. Eukaryotic expression vectors are commercially available, and the techniques to introduce them into cells are well known to those skilled in the art. The cells are incubated for 48-72 hours after transformation under conditions appropriate for the cell line to allow expression of CaBP. Phase microscopy is used to compare the mitotic index of transformed versus control cells. A decrease in the mitotic index indicates CaBP activity.

#### 20 XI. Production of CaBP Specific Antibodies

CaBP substantially purified using PAGE electrophoresis (see, e.g., Harrington, M.G. (1990) Methods Enzymol. 182:488-495), or other purification techniques, is used to immunize rabbits and to produce antibodies using standard protocols.

Alternatively, the CaBP amino acid sequence is analyzed using LASERGENE™ software (DNASTAR Inc.) to determine regions of high immunogenicity, and a corresponding oligopeptide is synthesized and used to raise antibodies by means known to those of skill in the art. Methods for selection of appropriate epitopes, such as those near the C-terminus or in hydrophilic regions are well described in the art. (See, e.g., Ausubel supra, ch. 11.)

Typically, oligopeptides 15 residues in length are synthesized using an Applied Biosystems Peptide Synthesizer Model 431A using fmoc-chemistry and coupled to KLH (Sigma, St. Louis, MO) by reaction with N-maleimidobenzoyl-N-hydroxysuccinimide

ester (MBS) to increase immunogenicity. (See, e.g., Ausubel *supra*.) Rabbits are immunized with the oligopeptide-KLH complex in complete Freund's adjuvant. Resulting antisera are tested for antipeptide activity, for example, by binding the peptide to plastic, blocking with 1% BSA, reacting with rabbit antisera, washing, and reacting with radio-iodinated goat anti-rabbit IgG.

## **XII. Purification of Naturally Occurring CaBP Using Specific Antibodies**

Naturally occurring or recombinant CaBP is substantially purified by immunoaffinity chromatography using antibodies specific for CaBP. An immunoaffinity column is constructed by covalently coupling anti-CaBP antibody to an activated chromatographic resin, such as CNBr-activated Sepharose (Pharmacia & Upjohn). After the coupling, the resin is blocked and washed according to the manufacturer's instructions.

Media containing CaBP are passed over the immunoaffinity column, and the column is washed under conditions that allow the preferential absorbance of CaBP (e.g., high ionic strength buffers in the presence of detergent). The column is eluted under conditions that disrupt antibody/CaBP binding (e.g., a buffer of pH 2 to pH 3, or a high concentration of a chaotrope, such as urea or thiocyanate ion), and CaBP is collected.

## **XIII. Identification of Molecules Which Interact with CaBP**

CaBP, or biologically active fragments thereof, are labeled with  $^{125}\text{I}$  Bolton-Hunter reagent. (See, e.g., Bolton et al. (1973) *Biochem. J.* 133:529.) Candidate molecules previously arrayed in the wells of a multi-well plate are incubated with the labeled CaBP, washed, and any wells with labeled CaBP complex are assayed. Data obtained using different concentrations of CaBP are used to calculate values for the number, affinity, and association of CaBP with the candidate molecules.

Various modifications and variations of the described methods and systems of the invention will be apparent to those skilled in the art without departing from the scope and spirit of the invention. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed should not be unduly limited to such specific embodiments. Indeed, various modifications of the described modes for carrying out the invention which are obvious to those skilled in molecular biology or related fields are intended to be within the scope of the following claims.

What is claimed is:

1. A substantially purified polypeptide comprising an amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or  
5 fragments thereof.
2. A substantially purified variant having at least 90% amino acid identity to the amino acid sequence of claim 1.
- 10 3. An isolated and purified polynucleotide encoding the polypeptide of claim 1.
4. An isolated and purified polynucleotide variant having at least 90% polynucleotide sequence identity to the polynucleotide of claim 3.
- 15 5. An isolated and purified polynucleotide which hybridizes under stringent conditions to the polynucleotide of claim 3.
6. An isolated and purified polynucleotide having a sequence which is  
20 complementary to the polynucleotide sequence of claim 3.
7. An isolated and purified polynucleotide comprising a polynucleotide sequence selected from the group consisting of SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, or fragments thereof.
- 25 8. An isolated and purified polynucleotide variant having at least 90% polynucleotide sequence identity to the polynucleotide of claim 7.
9. An isolated and purified polynucleotide having a sequence which is  
30 complementary to the polynucleotide of claim 7.
10. An expression vector containing at least a fragment of the polynucleotide of

claim 3.

11. A host cell containing the expression vector of claim 10.

5 12. A method for producing a polypeptide comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1, SEQ ID NO:2, SEQ ID NO:3, or fragments thereof, the method comprising the steps of:

a) culturing the host cell of claim 11 under conditions suitable for the expression of the polypeptide; and

10 b) recovering the polypeptide from the host cell culture.

13. A pharmaceutical composition comprising the polypeptide of claim 1 in conjunction with a suitable pharmaceutical carrier.

15 14. A purified antibody which specifically binds to the polypeptide of claim 1.

15. A purified agonist of the polypeptide of claim 1.

16. A purified antagonist of the polypeptide of claim 1.

20

17. A method for treating or preventing a nervous disorder, the method comprising administering to a subject in need of such treatment an effective amount of the pharmaceutical composition of claim 13.

25 18. A method for treating or preventing a vesicle trafficking disorder, the method comprising administering to a subject in need of such treatment an effective amount of the pharmaceutical composition of claim 13.

19. A method for treating or preventing a developmental disorder, the method  
30 comprising administering to a subject in need of such treatment an effective amount of the pharmaceutical composition of claim 13.

20. A method for treating or preventing a neoplastic disorder, the method comprising administering to a subject in need of such treatment an effective amount of the antagonist of claim 16.

5 21. A method for treating or preventing an immunological disorder, the method comprising administering to a subject in need of such treatment an effective amount of the antagonist of claim 16.

22. A method for treating or preventing a reproductive disorder, the method  
10 comprising administering to a subject in need of such treatment an effective amount of the antagonist of claim 16.

23. A method for detecting a polynucleotide encoding the polypeptide comprising the amino acid sequence selected from the group consisting of SEQ ID NO:1,  
15 SEQ ID NO:2, SEQ ID NO:3, or fragments thereof, in a biological sample, the method comprising the steps of:

- (a) hybridizing the polynucleotide of claim 6 to at least one of the nucleic acids in the biological sample, thereby forming a hybridization complex; and
- 20 (b) detecting the hybridization complex, wherein the presence of the hybridization complex correlates with the presence of the polynucleotide encoding the polypeptide in the biological sample.

24. The method of claim 23 wherein the nucleic acids of the biological sample  
25 are amplified by the polymerase chain reaction prior to hybridization.

1/3

|    |   |   |   |   |   |   |   |               |
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|    |   | D | X | D |   |   |   | EF Hand motif |

FIGURE 1A





3/3

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FIGURE 1C

## SEQUENCE LISTING

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 BANDMAN, Olga  
 HILLMAN, Jennifer L.  
 CORLEY, Neil C.  
 GUEGLER, Karl J.  
 LAL, Preeti  
 PATTERSON, Chandra

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| Cys | Phe | Ser | Leu | Tyr | Asp | Lys | Gln | Gln | Arg | Gly | Lys | Ile | Lys | Ala | 20  | 25  | 30  | 35  |
| Thr | Asp | Leu | Met | Val | Ala | Met | Arg | Cys | Leu | Gly | Ala | Ser | Pro | Thr | 40  | 45  | 50  | 55  |
| Pro | Gly | Glu | Val | Gln | Arg | His | Leu | Gln | Thr | His | Gly | Ile | Asp | Gly | 60  | 65  | 70  | 75  |
| Asn | Gly | Glu | Leu | Asp | Phe | Ser | Thr | Phe | Leu | Thr | Ile | Met | His | Met | 80  | 85  | 90  | 95  |
| Gln | Ile | Lys | Gln | Glu | Asp | Pro | Lys | Lys | Glu | Ile | Leu | Leu | Ala | Met | 100 | 105 | 110 | 115 |
| Leu | Met | Val | Asp | Lys | Glu | Lys | Lys | Gly | Tyr | Val | Met | Ala | Ser | Asp | 120 | 125 | 130 | 135 |
| Leu | Arg | Ser | Lys | Leu | Thr | Ser | Leu | Gly | Glu | Lys | Leu | Thr | His | Lys | 140 | 145 | 150 |     |
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Gly Ala Val Ser Phe Glu Asp Phe Ile Lys Gly Leu Ser Ile Leu
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aattgggaaa caaagaaaaa ctcggggagc caaaaaaaaaa gggcgggcgc gactat 1496

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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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|---|--|-----------|---|
| <b>(51) International Patent Classification <sup>6</sup> :</b><br><b>C12N 15/12, C07K 14/47, 16/18, A61K 38/17, C12Q 1/68, G01N 33/68</b>   |  | <b>A3</b> | <b>(11) International Publication Number:</b> <b>WO 99/49038</b><br><b>(43) International Publication Date:</b> 30 September 1999 (30.09.99)  |
| <b>(21) International Application Number:</b> PCT/US99/05555<br><b>(22) International Filing Date:</b> 15 March 1999 (15.03.99)<br><b>(30) Priority Data:</b><br>09/048,889 26 March 1998 (26.03.98) US<br><b>(63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Application</b><br>US 09/048,889 (CIP)<br>Filed on 26 March 1998 (26.03.98)<br><b>(71) Applicant (for all designated States except US):</b> INCYTE PHARMACEUTICALS, INC. [US/US]; 3174 Porter Drive, Palo Alto, CA 94304 (US).<br><b>(72) Inventors; and</b><br><b>(75) Inventors/Applicants (for US only):</b> BANDMAN, Olga [US/US]; 366 Anna Avenue, Mountain View, CA 94043 (US). HILLMAN, Jennifer, L. [US/US]; 230 Monroe Drive #12, Mountain View, CA 94040 (US). CORLEY, Neil, C. [US/US]; 1240 Dale Avenue #30, Mountain View, CA 94040 (US). GUEGLER, Karl, J. [CH/US]; 1048 Oakland Avenue, Menlo Park, CA 94025 (US). LAL, Preeti [IN/US]; 2382 Lass Drive, Santa Clara, CA 95054 (US). |  |           | <b>(74) Agents:</b> BILLINGS, Lucy, J. et al.; Incyte Pharmaceuticals, Inc., 3174 Porter Drive, Palo Alto, CA 94304 (US).<br><b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).<br><b>Published</b><br><i>With international search report.</i><br><i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i><br><b>(88) Date of publication of the international search report:</b><br>10 February 2000 (10.02.00) |
| <b>(54) Title:</b> HUMAN CALCIUM-BINDING PROTEINS   |  |           |   |
| <b>(57) Abstract</b><br><p>The invention provides human calcium-binding proteins (CaBPs) and polynucleotides which identify and encode CaBP. The invention also provides expression vectors, host cells, antibodies, agonists, and antagonists. The invention also provides methods for treating or preventing disorders associated with expression of CaBP.</p>  |  |           |   |

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# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 99/05555

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C12N15/12 C07K14/47 C07K16/18 A61K38/17 C12Q1/68  
G01N33/68

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C12N C07K A61K C12Q G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.    |
|------------|---|--------------------------|
| X          | STRAUSBERG R.: "National Cancer Institute, Cancer Genome Anatomy Project (CGAP)."<br>EMBL DATABASE ENTRY AA643750, ACCESSION NUMBER AA643750,<br>1 November 1997 (1997-11-01), XP002113340 abstract   | 4,5,8,<br>10,11          |
| A          | SCHÄFER B. W. ET AL.: "The S100 family of EF-hand calcium-binding proteins: functions and pathology"<br>TIBS TRENDS IN BIOCHEMICAL SCIENCES, vol. 21, no. 4, 1 April 1996 (1996-04-01), page 134-140 XP004050923<br>ISSN: 0968-0004<br>the whole document | 1-14,<br>17-19,<br>23,24 |
|            | -/--  |                          |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

25 August 1999

Date of mailing of the international search report

17.12.99

Name and mailing address of the ISA

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Mandl, B



# INTERNATIONAL SEARCH REPORT

International Application No

PC1/US 99/05555

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No.    |
|------------|---|--------------------------|
| P,X        | WO 99 04265 A (SAHIN UGUR ;TURECI OZLEM (DE); PFREUNDSCHUH MICHAEL (DE); GOUT IVA) 28 January 1999 (1999-01-28) SEQ.IDs. 24 and 46<br>---   | 1-14,<br>17-19,<br>23,24 |
| P,X        | STRAUSBERG R.: "National Cancer Institute, Cancer Genome Anatomy Project (CGAP)."<br>EMBL DATABASE ENTRY AA886335; ACCESSION NUMBER AA886335, 2 April 1998 (1998-04-02), XP002113341<br>abstract<br>----- | 4,5,8,<br>10,11          |

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US 99/05555

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:  
  
Although claims 17-22 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.
2. ☒ Claims Nos.: 15,16,20-22  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

See extra sheet, Invention 1.

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

International Application No. PCT/US 99/05555

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

### 1. Claims: 1-24 (partially)

A human calcium-binding protein comprising the amino acid sequence as depicted in SEQ.ID.1 or fragments thereof; a polynucleotide sequence encoding said calcium-binding protein or variants having at least 90% polynucleotide sequence identity; a polynucleotide which hybridizes under stringent conditions to a polynucleotide that encodes said calcium-binding protein; a polynucleotide comprising a polynucleotide sequence as depicted in SEQ.ID.4; an expression vector comprising at least a fragment of said polynucleotide; a host cell containing said expression vector; a method for producing said calcium-binding protein; a pharmaceutical composition comprising it; an antibody specific for said calcium-binding protein; an agonist of said calcium-binding protein; an antagonist of said calcium-binding protein; use of said calcium-binding protein or antagonist in medicaments for the treatment of nervous or neoplastic disorders, vesicle trafficking disorders, and developmental, immunological or reproductive disorders; and a method for detecting a polynucleotide encoding said calcium-binding protein.

### 2. Claims: 1-24 (partially)

A human calcium-binding protein comprising the amino acid sequence as depicted in SEQ.ID.2 or fragments thereof; a polynucleotide sequence encoding said calcium-binding protein or variants having at least 90% polynucleotide sequence identity; a polynucleotide which hybridizes under stringent conditions to a polynucleotide that encodes said calcium-binding protein; a polynucleotide comprising a polynucleotide sequence as depicted in SEQ.ID.5; an expression vector comprising at least a fragment of said polynucleotide; a host cell containing said expression vector; a method for producing said calcium-binding protein; a pharmaceutical composition comprising it; an antibody specific for said calcium-binding protein; an agonist of said calcium-binding protein; an antagonist of said calcium-binding protein; use of said calcium-binding protein or antagonist in medicaments for the treatment of nervous or neoplastic disorders, vesicle trafficking disorders, and developmental, immunological or reproductive disorders; and a method for detecting a polynucleotide encoding said calcium-binding protein.

### 3. Claims: 1-24 (partially)

A human calcium-binding protein comprising the amino acid sequence as depicted in SEQ.ID.3 or fragments thereof; a polynucleotide sequence encoding said calcium-binding protein or variants having at least 90% polynucleotide sequence identity; a polynucleotide which hybridizes under

## INTERNATIONAL SEARCH REPORT

International Application No. PCT/US 99/05555

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

stringent conditions to a polynucleotide that encodes said calcium-binding protein; a polynucleotide comprising a polynucleotide sequence as depicted in SEQ.ID.6; an expression vector comprising at least a fragment of said polynucleotide; a host cell containing said expression vector; a method for producing said calcium-binding protein; a pharmaceutical composition comprising it; an antibody specific for said calcium-binding protein; an agonist of said calcium-binding protein; an antagonist of said calcium-binding protein; use of said calcium-binding protein or antagonist in medicaments for the treatment of nervous or neoplastic disorders, vesicle trafficking disorders, and developmental, immunological or reproductive disorders; and a method for detecting a polynucleotide encoding said calcium-binding protein.

## INTERNATIONAL SEARCH REPORT

International Application No. PCT/US 99/05555

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 15,16,20-22

Present claims 15,16,20-22 relate to a compound defined by reference to a desirable characteristic or property, namely its antagonistic or agonistic effect on a calcium-binding protein, respectively, without giving a further characterization of the claimed matter. In consequence, the scope of said claims is ambiguous and, moreover, their subject-matter is vague and not sufficiently disclosed.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

**Information on patent family members**

PC./US 99/05555

Form PCT/ISA/210 (patent family annex) (July 1992)